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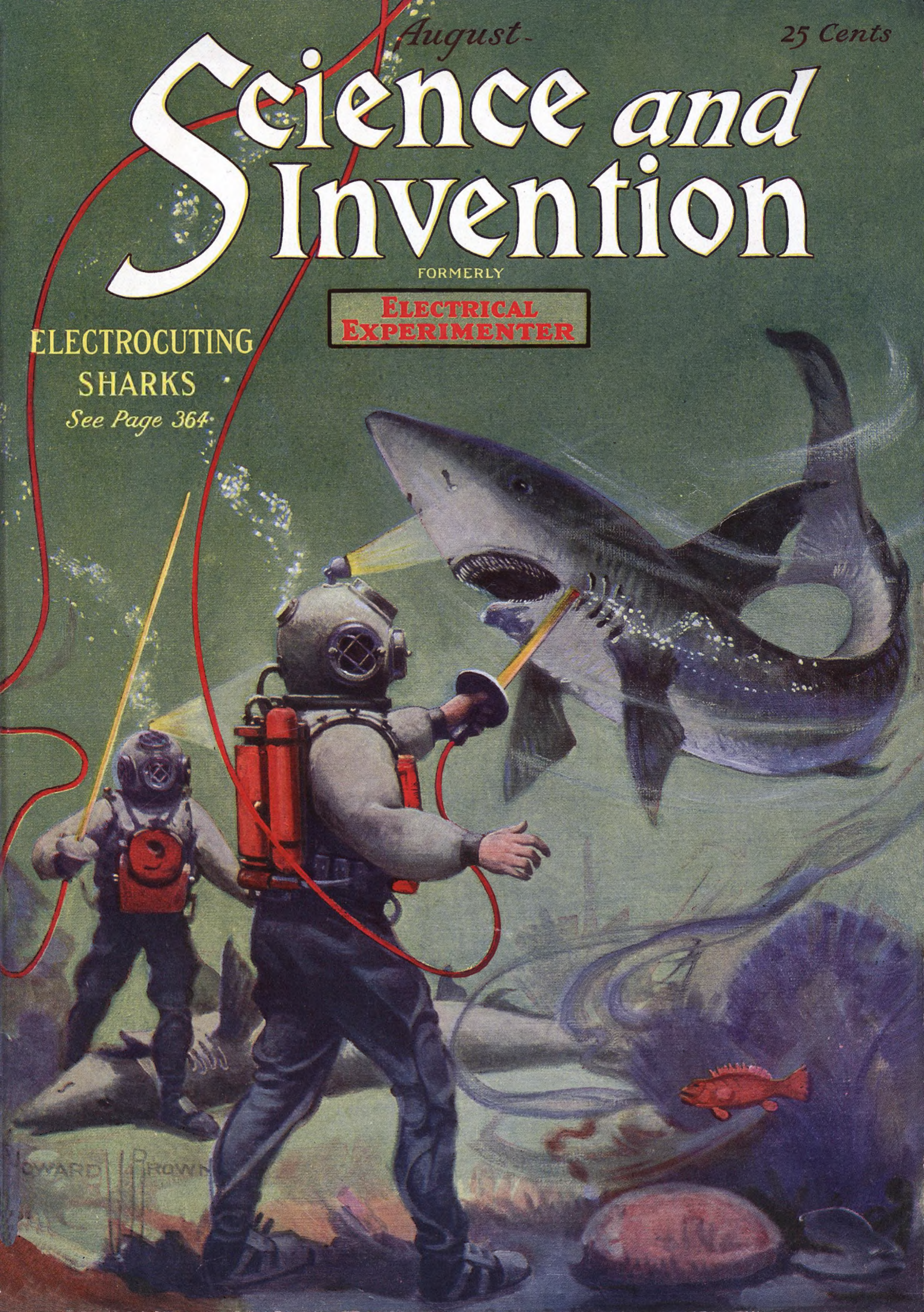
Science and Invention

FORMERLY

ELECTRICAL EXPERIMENTER

ELECTROCUTING SHARKS

See Page 364



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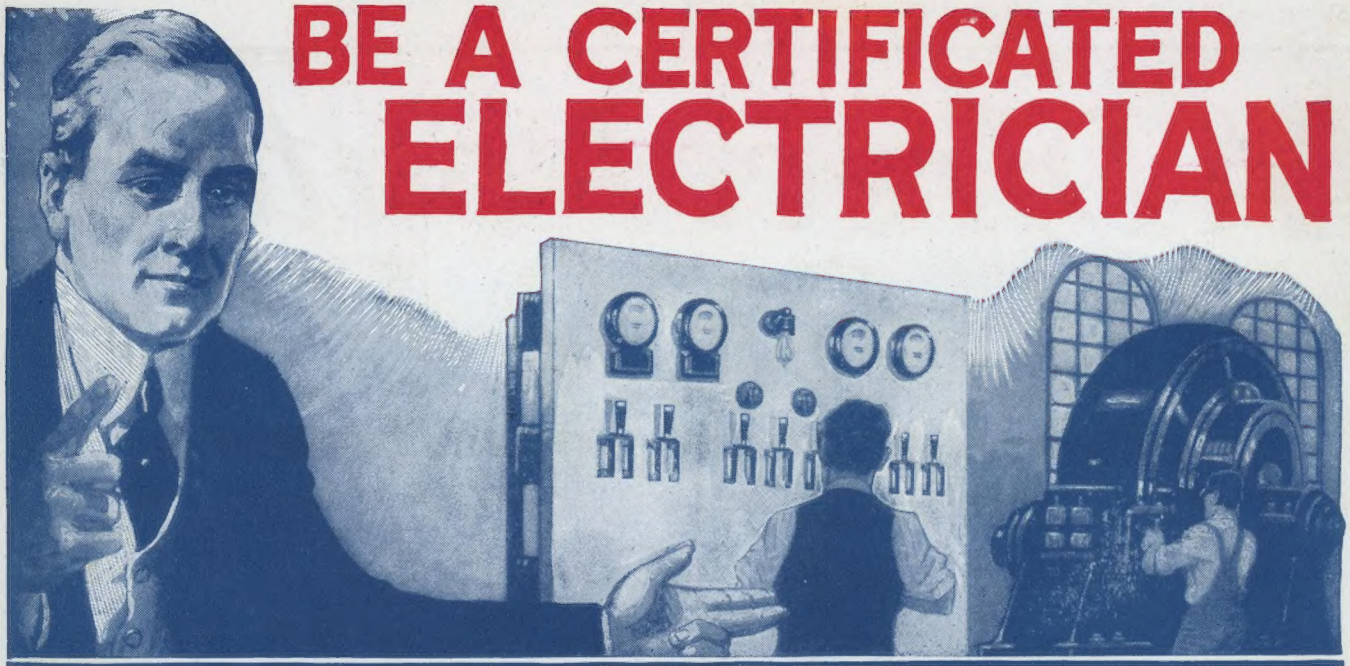

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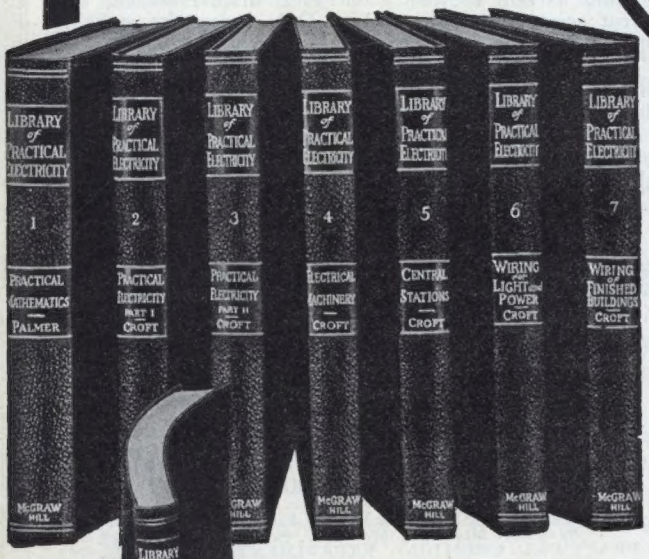

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Vol. VIII
Whole No. 88

Science and Invention

FORMERLY
ELECTRICAL EXPERIMENTER
233 FULTON STREET-NEW YORK

August, 1920
No. 4.

Publisht by Experimenter Publishing Company, Inc. (H. Gernsback, Pres.; S. Gernsback, Treas.; R. W. DeMott, Sec'y), 233 & 236 Fulton Street, New York.

Science and Invention

THE word *Science,* from the Latin *scientia,* meaning knowledge, is closely related to *Invention,* which, derived from the Latin *inventio,* means, finding out. There is little in Science that did not at one time require some inventive powers, while conversely most of the world's inventions are based upon one or more of the sciences.

But "invention" antedates "science" by thousands of years. When our prehistoric man first fashioned his crude hammer by binding a stone to a stick, by means of reeds, he had made a basic invention in every sense of the word. And when he first applied his stick to a huge boulder he wisht to move, then placing a smaller stone under the stick—he had made another notable basic invention—the lever.

In fact, both of these basic inventions are discoveries, and if they were first made today, would be patentable. Right here we may state that in patent law "discovery" and "invention" are held to be synonymous, tho popularly an "invention" designates one that is new and useful as well as patentable.

Science, or rather the sciences, on the other hand first came into being with the ancient Greeks. Of course, some sciences existed before the Greeks, but they were not recognized as such. At least there is no record of any sciences classified as such by the Phoenicians or the old Egyptians. Even in Grecian times there were comparatively little sciences. Thus the Platonists had their sciences divided into dialectics, physics and ethics.

Even in comparatively modern times there seems to be little agreement as to what the sciences really comprise. Thus Bacon in 1605 has history, poesy, and philosophy as his sciences. As late as 1830 Comte classifies the sciences into six parts in their following orders: Mathematics, astronomy, physics, chemistry, physiology and sociology.

Even today there exists no classification of the sciences that would be acceptable to all of our great thinkers.

The general public and "the man in the street" possibly come nearer the actual definition of "science" than most of our philosophers. To the public, the arts, discoveries, inventions—all fall under the term of science. Anything under the sun nowadays becomes a "science"—be it the science of cooking, the science of darning socks, or the science of cleaning streets.

The myriad of inventions and discoveries all tend to make the world more "scientific" and whether we like it or not, one science or another creeps into every one of our homes. We are surrounded with science all day long as well as during the night. Science does this thing for us, and makes us do that. There is no escaping it and the general public has awakened to the fact but yesterday, that science no longer is the sombre book closed with seven seals. Quite the contrary, it is the public that popularizes science—not our scientists. Just at present, for instance, educational scientific films are all the rage and the public clamors for more and heartily applauds them.

But our *real* scientists are as backward as in Galileo's times. The public applauds and instantly believes in anything new that is scientific, whereas the true scientist scoffs and jeers, just as he did in Galileo's times when that worthy stoutly maintained that the earth moved and did not stand still.

Then as now they burn our great discoverers and our great scientists at the stake. Only today the stake is moral and the fire derision.

It matters little that Jules Verne or Nikola Tesla are a hundred years ahead of the times—the scientists scoff and laugh unbelievingly.

But happily, the great public today appreciates the "fantastic dreamer", because it knows from experience that these "fantastic dreams" have a habit of coming true on the morrow.

H. GERNSBACK.

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SCIENCE AND INVENTION is publisht on the 15th of each month at 233 Fulton Street, New York. There are 12 numbers per year. Subscription price is $3.00 a year in U. S. and possessions. Canada and foreign countries, $3.50 a year. U. S. coin as well as U. S. stamps accepted (no foreign coin or stamps). Single copies, 25 cents each. A sample copy will be sent gratis on request. Checks and money orders should be drawn to order of EXPERIMENTER PUBLISHING CO., Inc. If you change your address notify us promptly, in order that copies are not miscarried or lost.

All communications and contributions to this journal should be addrest to: Editor, SCIENCE AND INVENTION, 233 Fulton Street, New York. Unaccepted contributions cannot be returned unless full postage has been included. ALL accepted contributions are paid for on publication. A special rate is paid for novel experiments; good photographs accompanying them are highly desirable.

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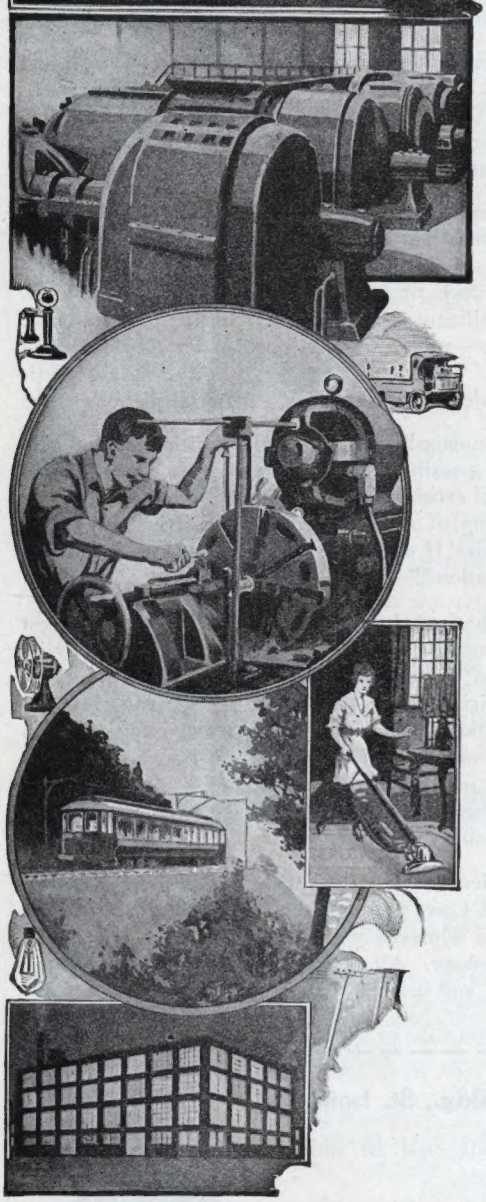

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Volume VIII.
Whole No. 88

Science and Invention

H. GERNSBACK – EDITOR
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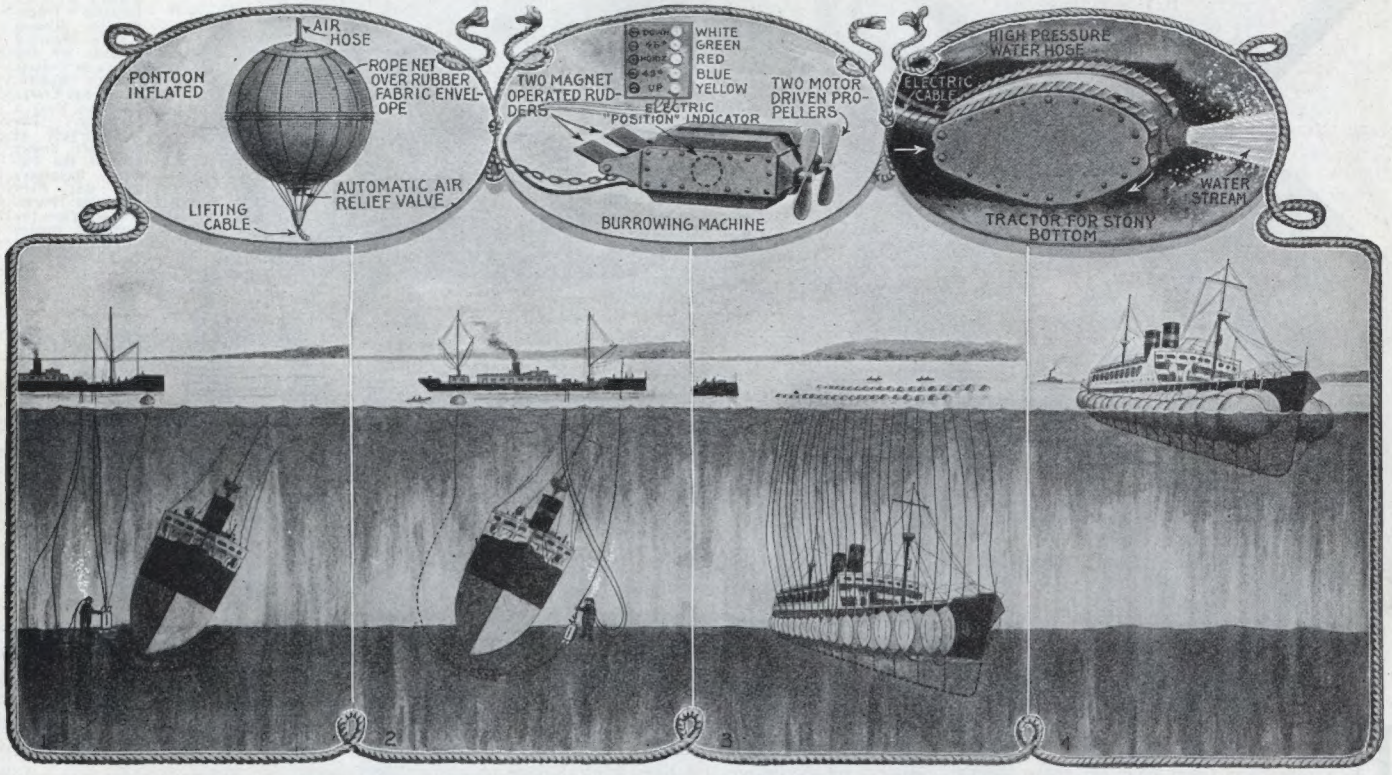
AUGUST
1920
No. 4

Electric Sand-Hog to Salvage Ships

By ERIC A. DIME

THE recovery of treasures from the bottom of the sea has been a dream of inventors since times immemorial. The wrecks, which rest in the silt and sand of the ocean's floor, have served as an incentive to men to devise ways and means whereby the hidden wealth could be raised and salvaged. The idea of lifting sunken vessels is now receiving possibly more attention than it ever did in the history of the world. The reason for this salvaging interests, but also those that are lost annually through unavoidable maritime accidents. In European waters and along our Atlantic coast the ocean's bottom is strewn with hundreds of wrecks which could be salvaged if a proper equipment were employed for raising the vessels. There is nothing new or remarkable about raising wrecked ships. Such feats are taking place practically all the time. According to statistics at hand, altho they are not of recent



The Latest Scientific Device for Salvaging Ships Is This Electrically Driven Sand-Hog, Which Burrows Its Way Down and Around the Ship, Permitting Cables to Be Past About the Hull. Finally, Pontoons Are Fastened to These Cables and Inflated, Lifting the Ship.

is the immense tonnage of ships lost during the World War.

According to well-informed authorities, it is claimed that the vessels sent to Davy Jones' locker, while the hosts of the fighting nations were contending supremacy on land and sea, represent a tonnage of 15,000,000. The monetary value involved in this tonnage is about eight billion dollars, which is a sum greater than the national debt incurred during our Civil War. To make the comparison more striking and interesting it might be said that this staggering sum is greater than the total output of gold in the United States, and it is in excess of the wealth taken from the diamond mines of South Africa during their entire period of exploitations.

It is not only the ships, lost during the war, which are attracting the attention of date, we find that up until August of last year the salvage department of the British Admiralty had recovered 440 vessels sunk during the war. These ships represented a value of $250,000,000.

The ships, which so far have been raised, are those resting in shallow waters or at depths of about 100 feet. Wrecks, which are lying at depths of from 200 to 300 feet or more have up until the present time remained where they are, because there has been no satisfactory method employed whereby such vessels could be lifted from the ocean's floor. It is conceded that any ship could be raised, provided a sufficient number of pontoons could be attached to the vessel for lifting purposes. But the drawback so far has been the lack of supports for holding the pontoons in position and allowing them simultaneously to give a direct upward lift sufficient to raise the ship.

THE ELECTRIC SAND-HOG INVENTED.

A device to overcome all these difficulties has recently been invented by a New Yorker, a Mr. A. B. Saliger, who has spent several years in perfecting a machine that is unique in construction and from all appearances practical in application. He calls it the *burrowing machine*, and it is so different from anything else used for the salvaging of ships that he has been granted basic claims on it. As its name implies the *burrowing machine* is employed to dig its own way thru sand, silt and gravel in which a wreck rests on the ocean's bottom. The device is made to carry or haul a line under the hull of the ship, and when that is accomplished it is an easy matter to string heavy cables under the vessel and then attach the pontoons to the cables for lifting purposes.

The *burrowing machine* resembles a double torpedo, or two torpedoes joined together like a pair of Siamese twins. The front has two propellers, some fifteen inches in diameter, rotating in opposite directions. The machine is 4 feet wide, 2 feet high and 5 feet long. The rear is equipt with a pair of horizontal rudders, very much like those of a torpedo. The main body of each sec-

(*Continued on page* 434)

Man-Made Rubies

By O. IVAN LEE, B. Sc.

The Wonderful Story of the Artifical Ruby that Rivals the Genuine Stone in Lustre, Hardness and Color

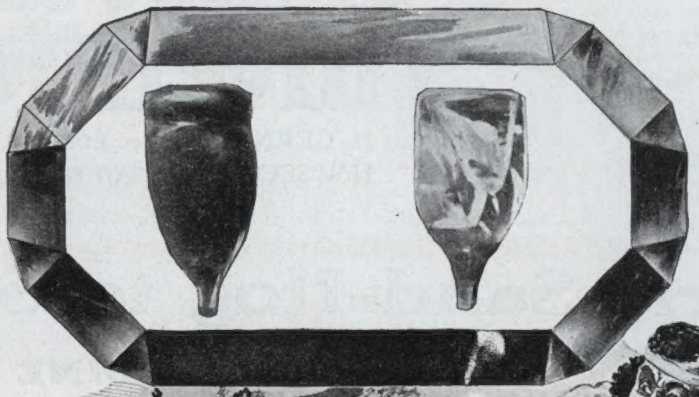
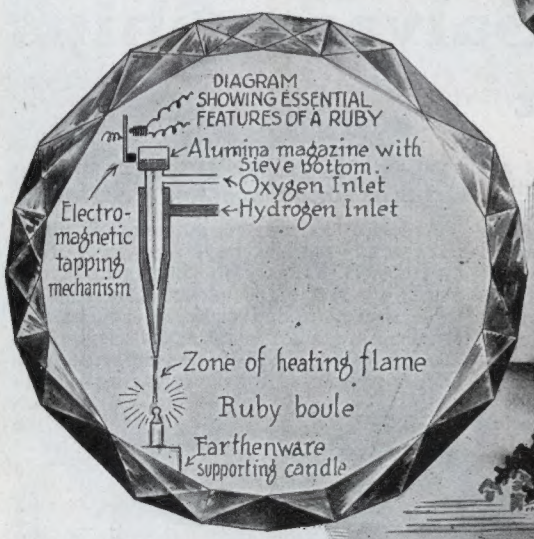
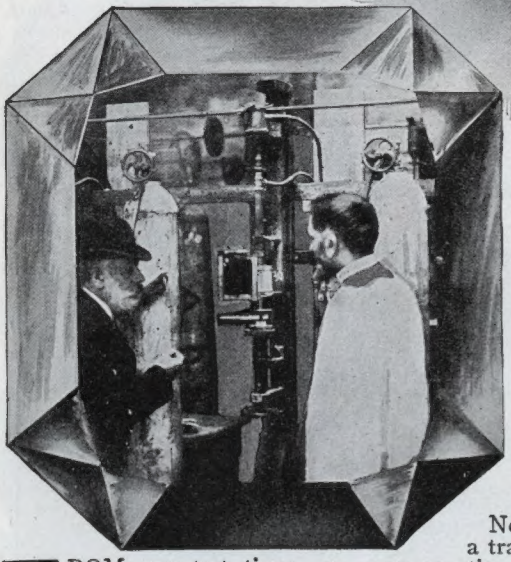
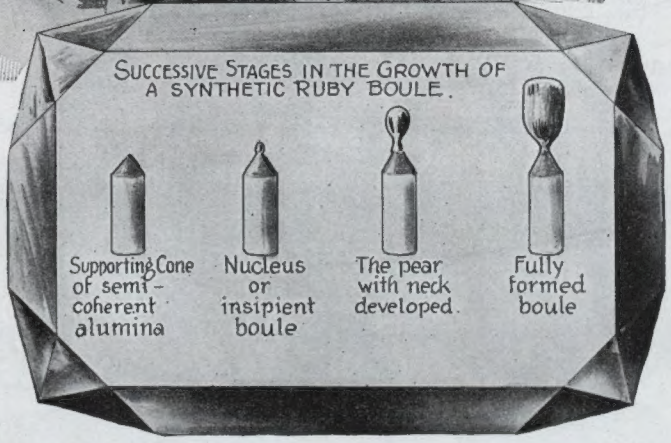


Photo at Left Shows Two Large Ruby Boules In the Collection at Columbia University, New York City. The Boule at the Extreme Right Shows Fracture Cracks Caused by the Unequal Expansion and Contraction and Set-Up Particularly by the Rapid Cooling of the Outer Surfaces of the Boule. From These Boules the Most Perfect Rubies Imaginable Are Cut.



For Centuries the Ruby Was "the Gem of Gems;" Some of the Greatest Tragedies In History Have Occurred Because of the Desire to Possess Famous Rubies. But Today Every-One Can Have a "Ruby." The Inset Photo at the Left Shows One of the Famous Oxyacetylene Gas Furnaces in Paris, France, Where the Synthetic Rubies Are Made by the Thousand.




SUCCESSIVE STAGES IN THE GROWTH OF
A SYNTHETIC RUBY BOULE.
Supporting Cone of semi-coherent alumina
Nucleus or insipient boule
The pear with neck developed.
Fully formed boule

The Progressive Diagram at the Left Shows the Successive Stages Gone Thru by the Synthetic Ruby Chemist In Building Up the Chunk of Precious Glass-Like Substance From Which Future Rubies Are To Be Cut to Adorn the Fingers, Arms and Necks of the Fair Sex. Synthetic Rubies Are Available in All Sizes Up to 50 carats.

FROM remotest times, an ever accumulating lore of gems and precious stones has been past on from generation to generation, and altho prosaic science has classified and card-indexed this vast array of heterogeneous information, not yet has it completely explained or eradicated that primitive impulse which attracts us irresistibly to stones which sparkle. There is still something of the savage in all of us; and it may be that things which glitter appeal to the same instinct which finds a fascination in flames.

Of the many varieties of gems which have stood the acid test of the world's favor, the diamond and the ruby easily lead, for if the former is the premier of jewels by reason of its hardness and fire, the latter is the peer of all colored stones—tinged as it it with the hue of the blood which gives us life. They are thus symbolical of the evolution of the race which has struggled upwards thru centuries of fire and blood—their very existence may be mineralogically paraphrased in the Darwin theory as the "survival of the hardest."

No doubt coincident with the growth of a traffic in gems was their extensive imitation, for since the beginning of time, the possession of anything rare, beautiful, expensive or exclusive has been a challenge to duplication with something just as good, and *cheaper!*

The Egyptians and Romans were skilled in imitating precious stones, indeed, the art of making glass owes much to this base incentive, and their skill was made the foundation of a craftmanship which in later ages produced counterfeits of which the buyer had ever to beware.

The science of mineralogy developed during the Nineteenth Century did much not only to systematize the classification of gems and make easier their identification, but, since mineralogy is a handmaiden of chemistry, a new hope was born—not that of imitating, but actually *creating* the gems themselves. Heretofore, with the debatable exception of pearls which had been produced in the Orient by introducing foreign matter into the pearl forming mollusk, all the attempts at counterfeiting had been frankly *imitative*. In the light of exact chemical knowledge of gem materials, the possibility of reproducing their substance was now seen, and from this conception has been painfully evolved a true miracle of the atoms—the commercial manufacture of veritable rubies.

WHAT THE RUBY IS.

Essentially, the ruby is the oxid of that modern and indispensable metal, aluminum. It occurs naturally as the mineral *corundum,* a familiar variety being the abrasive *emery.* which, however, contains in addition a large proportion of iron. Before going further, it should be explained that practically all gem stones when absolutely pure, are colorless, the particular color which a certain kind of stone may possess is then accidental and not inherent, and merely a detail of the problem of reproducing its *characteristic substance.*

Boiled down, then, making a true ruby necessitated only the making of transparent alumina, that is, apparently, merely *fusing* it.

Under ordinary conditions, aluminum oxid becomes liquid in the vicinity of 2,000 C. (3,632 F.). The fusion of alumina was actually accomplisht over a hundred years ago, for it is recorded in 1819 that if two

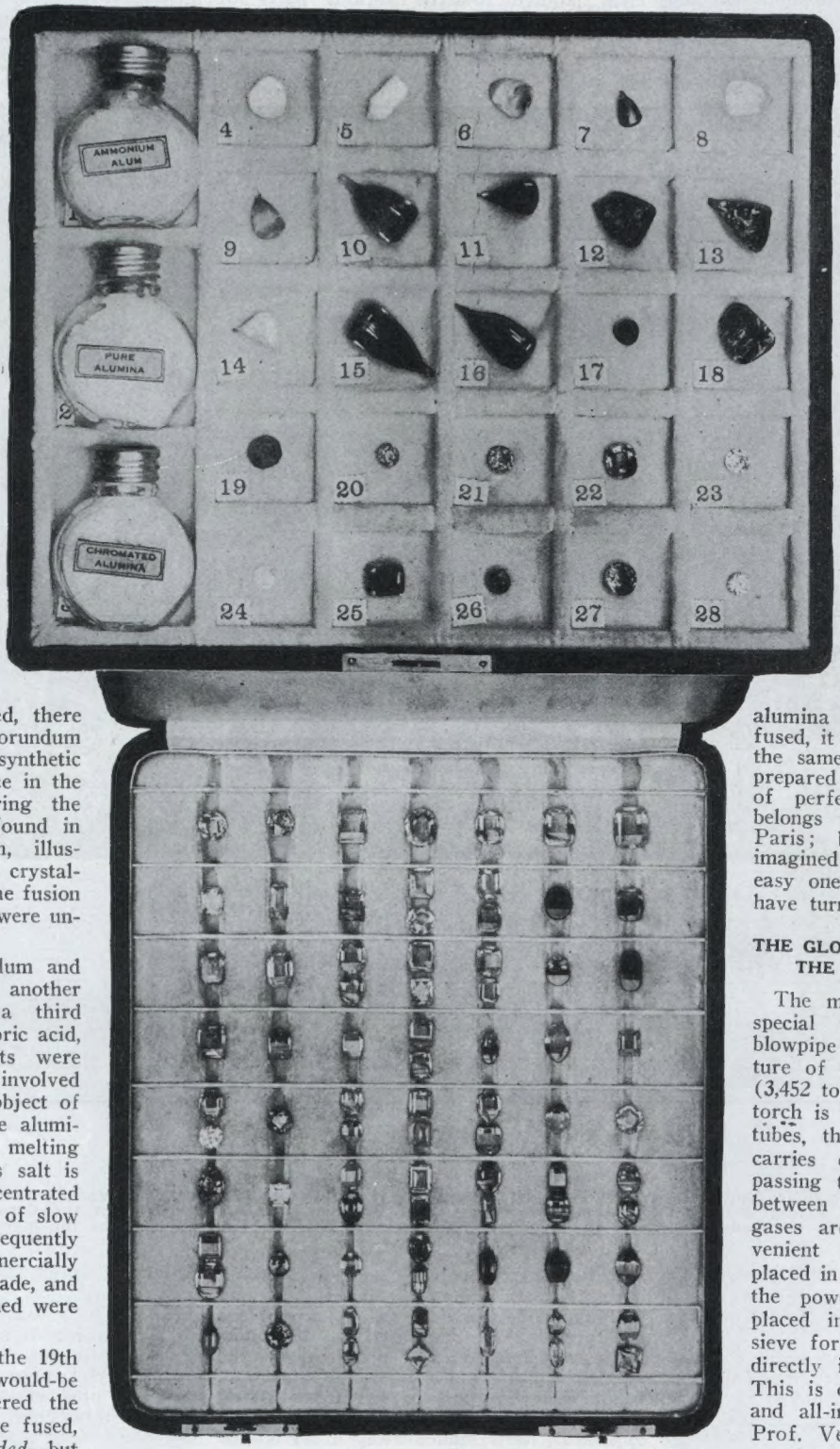
rubies were exposed on charcoal to the flame of an oxy-hydrogen blowpipe, they could be melted thereby into a single bead. The pioneer experimenters and their followers, endeavoring to make rubies were evidently so engrost in trying to make *crystalline* alumina and so beset with their individual difficulties, that they could not see the woods for the trees and for a long time never realized the value of its hint which lay at hand.

By purely chemical methods, numerous workers were successful in producing crystallized aluminum oxid, but since in each case the crystals obtained were exceedingly thin and often microscopic, the material obtained could not be utilized for cutting. If the reader has ever had the opportunity of examining a well crystallized piece of that synthetic abrasive *par excellence*, carborundum or silicid of carbon, it will have been noticed that the hexagonal crystals are excessively thin, compared to their diameter. The writer has before him a particularly pure such specimen in which the crystals are perfectly transparent and of a beautiful emerald green color. They are harder than the ruby and nearly as hard as a diamond. One of them measures half an inch in diameter. But for the fact that they are scarcely thicker than the paper on which this is printed, there is little doubt that carborundum would be a popular synthetic gem, having no existence in the mineral kingdom, barring the fact that it has been found in meteorites. This, then, illustrates the form of the crystalline rubies obtained by the fusion methods, and why they were unsatisfactory.

One chemist fused alum and potassium sulfate, another alumina and borax, a third aluminum fluorid and boric acid, and clever improvements were made on the principle involved in these reactions, the object of which was to crystallize aluminum oxid from a lower melting solvent or flux, just as salt is deposited from a concentrated brine solution. In spite of slow cooling, lasting not infrequently for weeks, no commercially available material was made, and the small crystals obtained were very costly.

In the latter part of the 19th Century, one of the would-be ruby makers re-discovered the fact that rubies could be fused, or, more correctly, *welded*—but not until some years later was it found that welded rubies were crystalline in structure and not amorphous like glass. On this account the value of the discovery was again overlooked.

With the general introduction of the oxyhydrogen flame, renewed efforts had been made to fuse aluminum oxid into transparent corundum, but without success. Quartz, which melts higher, was fused, but the alumina, altho clear as long as under the flame, persistently became opaque when the test was removed. One of these experimenters, after years of fruitless endeavor has recorded his belief that it was impossible to achieve the desired material because of this tendency. It had been found, too, that aluminum oxid virtually sublimes: that is, the melting point and boiling point were so close together that the alumina suddenly becomes fluid and then quickly boils away. This fact has mitigated against the employment of the electric furnace in making rubies.



Photos Courtesy of Heller & Son

The Top Tray Here Shown, Represents One of the Most Interesting Collections Ever Gotten Together. It Shows the Ingredients or Chemicals Used to Produce "Synthetic" Rubies in the Fierce Heat of the Oxycetyline Flame and Thereafter, the Successive Stages in Forming and Cutting Various Shapes. The Lower Tray Shows Several Dozen Varieties and Shapes of "Synthetic" Rubies, Each One of Which so Closely Resembles a Genuine Ruby Obtained from Mines, That Even Experts Are Fooled Unless They Have the Very Highest Precisional Instruments. No Average Jeweller Could Tell by Looking at Them, Whether or Not They Are the Scientific or Genuine Ruby. The Electroscope or Ultra-Powerful Compound Microscope Only Will Tell the Difference. They Are of Exactly the Same Hardness and Invariably Possess the Same Lustre and Color as the Stone Gotten from Mother Earth, Except That Instead of Requiring Hundreds of Years in Which to Crystallize and Form, These Scientific Rubies Took but a Few Moments to Make in the Skillful Hands of the Modern Chemist.

THE FIRST RECONSTRUCTED RUBY APPEARS.

All these difficulties were very discouraging, and so, one by one, the workers gave up the quest as hopeless. One day, however, rubies were offered for sale in Europe, whose source could not be satisfactorily accounted for. It was said in explanation that a ruby mine had been discovered near Geneva, Switzerland, but eventually the secret came out. It seemed that a Swiss priest had been experimenting with natural ruby chips obtained from the lapidaries, had fused these fragments into larger stones, cut them and circulated them as mined rubies—which was perfectly true in one sense. Naturally, the profit was a handsome one. These *reconstructed* rubies, as they are termed, are even yet an article of commerce, and altho the technique of their manufacture has been much improved, they are still inferior in color, tenacity and structure to the artificial ruby of which they were the forerunners: that is, the *synthetic* ruby.

Since it was now conclusively demonstrated that natural alumina could be successfully fused, it only remained to apply the same process to chemically prepared material and the honor of perfecting this industrially belongs to Prof. Verneuil, of Paris; but it must not be imagined that his task was an easy one or that anyone could have turned the trick.

THE GLORY OF THE CHEMIST—THE SYNTHETIC RUBY.

The machine now used is a special type of oxyhydrogen blowpipe producing a temperature of from 1,900 to 2,400 C. (3,452 to 4,352 F.). The blow-torch is built of two concentric tubes, the inner one of which carries oxygen, the hydrogen passing thru the annular space between the two tubes. The gases are supplied from convenient tanks. The torch is placed in a vertical position and the powdered aluminum oxid placed in a little box with a sieve for a bottom and opening directly into the oxygen tube. This is one of many ingenious and all-important details which Prof. Verneuil devised, for it can be readily appreciated that a blast of flame directed on a pile of light and non-coherent alumina powder would blow it away before it had any opportunity to attain a welding temperature. A little hammer, actuated by electromagnetic means,

(*Continued on page* 416)

100 H.P. Voice for Conventions

FOR the first time in its history the attendance at the Republican National Convention was too large to hear the speaker's voice. So now electricity, in the guise of the *loud-speaking telephone,* wraps its strength around the voice of the orator and gives it power and volume to reach the distant auditor with all its expression and its timbre intact. National conventions have depended more on visual rather than audible interest. There has, of course, been a chorus of applause which all could hear, but much of what has been said was read rather than heard even by those who were present.

Just in time for the Republican Convention the engineers of the Bell Telephone System successfully completed a voice magnifying apparatus embodying newly discovered features of telephony, which the inventor of the telephone could not have foreseen. In the Coliseum's vast auditorium the experts of the American Telephone and Telegraph Company, the Western Electric Company and the Chicago Telephone Company worked for ten long days installing the intricate apparatus thru which electricity, the master magician, served clear and distinct sound to the occupants of the most distant seats. There was little to see of the miracle-working mechanism in the great convention hall. An inconspicuous transmitter of speech, raised up a few feet from the front of the speaker's platform, and overhead were suspended several receivers, rectangular wooden horns, ten feet long, with their open ends pointed towards various parts of the auditorium. The flags and bunting were still the conspicuous eye-catchers. Without seeing how it is done, the audience found that as far as hearing was concerned the great crowd was telescoped by the public address system in close proximity to the speaker's platform. Under the floor and behind the walls ran the wires which lead to and from the *Audion speech magnifying apparatus,* itself hidden away in an unseen part of the building.

The loud speaking telephone system which the Bell System placed in the Coliseum at Chicago, and in the San Francisco convention also, has been in process of development for about ten years. The experiments have been numerous and of great scientific interest, but there has also been a romantic side to the work, which was mostly done in the laboratories of the Bell System, situated on one of the busiest and noisiest waterfront streets in New York. Amidst all the rattle and bang of a thousand teams and motor trucks pounding the stone pavement, teamsters thinking of nothing but their right-of-way were startled to hear a strange voice, apparently close to their ears, deliberately and clearly counting above all the confusion, "one, two, three, four," or reciting some rhyme like "Hickory, dickory, dot, the mouse ran up the clock." Those teamsters could hardly see the horn on the roof of the lofty laboratory building, nor guess that tests were being made which would facilitate the nomination of a presidential candidate. The best the teamsters could do was to wonder how they could hear these tests in spite of the nearest load of angle iron which was clattering over the cobbles.

On a foggy night a little group of Bell telephone engineers crossed the Hudson River and from the roof of the Pennsylvania Station listened while the same ryth-

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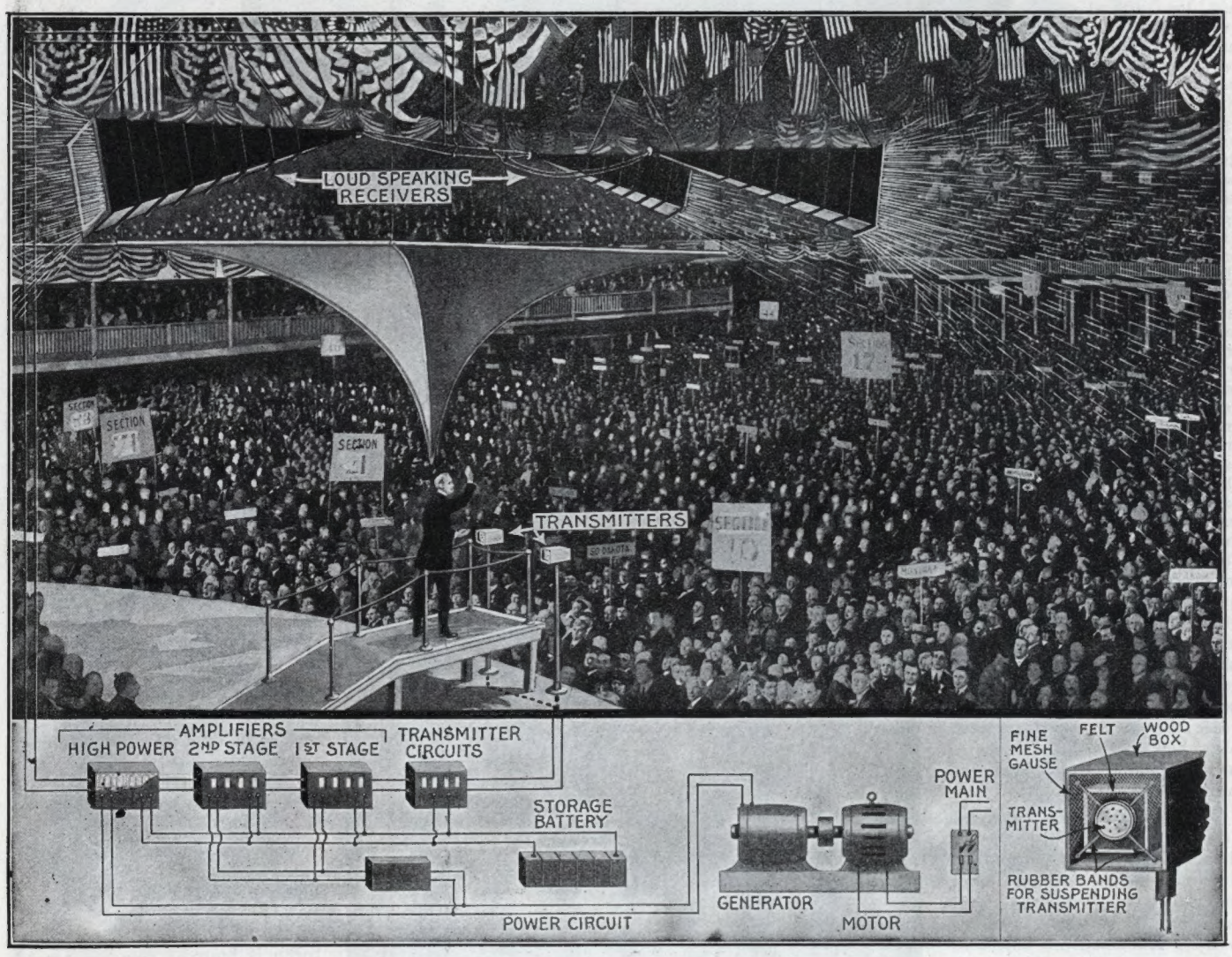


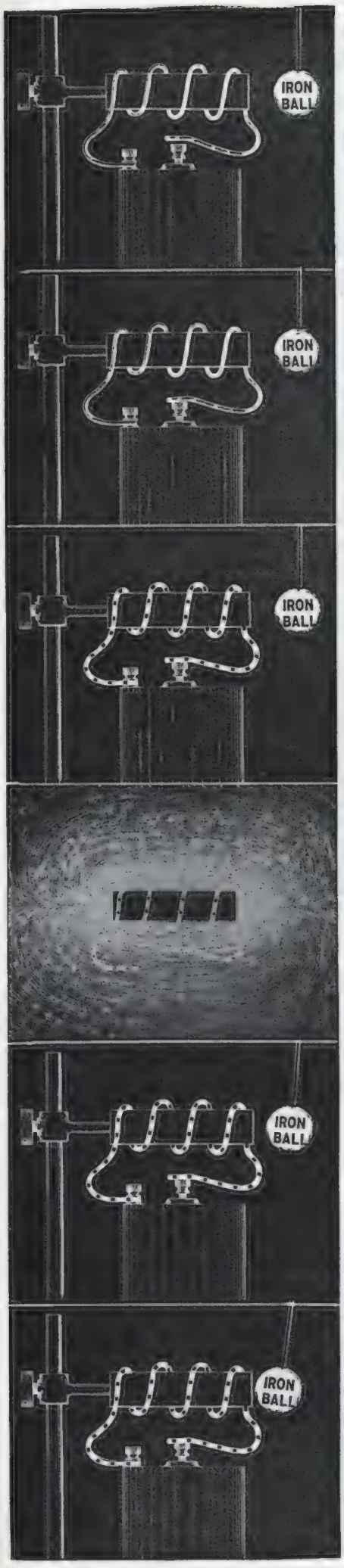
The Republican and Democratic Conventions Both Had the Assistance of "Madame Science" This Year in the Guise of a Powerful, Loud-Talking Telephone. Fitted With Audion Amplifiers, These Loud Talkers Enabled Everyone in the Crowd of 15,000 People to Hear the Speakers—Even the Women, Who Usually Do Not Talk as Loud as the Men.

"Movies" of the Unseen

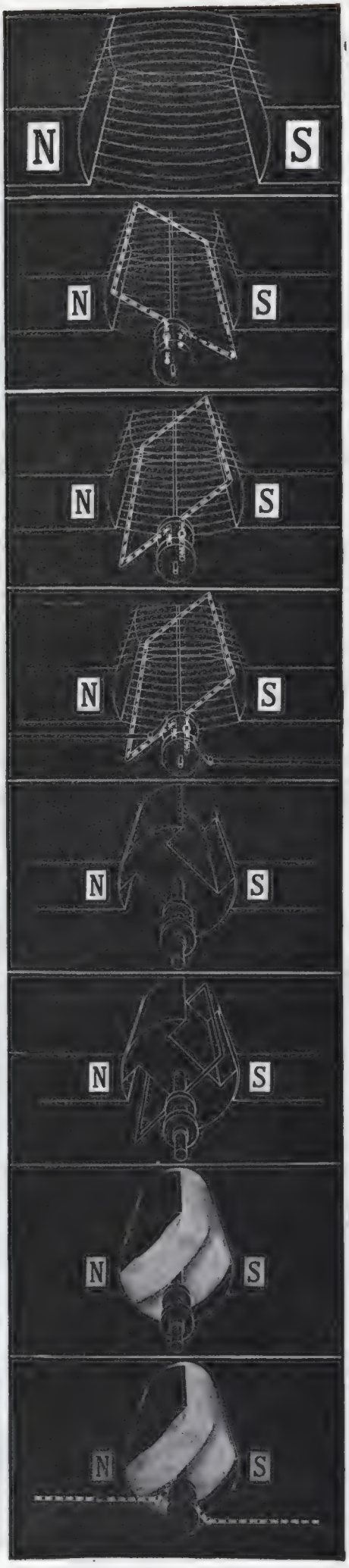
By JEROME LACKENBRUCH

IF you could SEE an idea; if the imaginings of an inventor's mind could be photographed and shown to you objectively; if the electrical theories written about in text-books could be brought to life and represented in diagrams that change and explain their development as you look at them, the task of learning just how electricity and magnetism act and what really happens when a generator is creating an alternating current, would be greatly simplified. Modern ingenuity has found a way to show these things. In fact, anything that can be imagined, may now be presented in pictorialized form. And this comparatively recent discovery of the means to show ideas in a way that anyone may comprehend them is due to an invention connected with the making of motion pictures. The particular method employed is known as the animated technical drawing and is the invention of the Bray studios.

In showing electrical phenomena on the screen, about 1,500 to 2,000 individual drawings, together with about a dozen backgrounds, must first be made. These are traced on celluloid composition plates and



The Movie Strip at Left Shows a Few Stages of the Several Hundred Drawn by the Artist in Making the Actual Motion Picture,—"the Story of the Electro-Magnet and How It Works." First, the Circuit is Shown Closed, Then With the Current Flowing, Next the Magnetic Field Produced About the Magnet, and Finally the Ball Being Attracted to the Magnet Pole.



Right-hand Film Strip Shows a Few of the Pictures out of Several Hundred Employed to Illustrate Vividly "the Action of the Dynamo." The Actual Movie of the Dynamo is Wonderful Indeed,—the Armature Wire and Core Spinning Around, Cutting the Magnetic Flux Lines and the Current Passing Out Thru the Brushes in a Very Clear Manner.

the plates then photographed on a table by an inverted motion picture camera. The negative film is then developed as an ordinary motion picture; and the reel is cut and edited so as to reveal the subject in its clearest form.

As the aim of the art of the motion picture is to tell a story by means of pictures, the animated technical drawing must illustrate every phase in the process of the subject it presents. Often simple comparisons are employed and the particular phase of the subject to be explained gradually dissolved into the film. For example, in explaining the meaning of voltage, a stream of water is shown running thru a cross-section of piping. Now the water pipe fades into the picture of a wire, and the flow of an electric current indicated. Several drawings are made to show the current in motion; and when these have been photographed on the film negative and then shown in a projection machine, the illusion of moving current is attained.

One of the accompanying diagrams shows the first attempt at a series of animated technical drawings to explain the action of *Magnetism*. The diagram contains a battery, an iron core with a wire wound about it, and an iron ball suspended a short distance from the bar. Now in this first diagram the apparatus is drawn on a black background, but the wire that is seen to be disconnected is drawn on an individual plate, placed over the background and thus photographed on the film negative. The reason for this is that the connecting wire is later removed and another, showing the connection made (second figure from top), substituted. In this way, the same back-

(*Continued on page* 429)

First Electric Welded Building

By H. B. PAYNE*

THE interesting thing about electric arc welding is not so much the method which is employed, but rather the constantly widening application that it has as an industrial process. Since the discovery of electric arc welding, considerable progress has been made in developing various kinds of equipment to make its use more easy and general. But the real science of electric arc welding lies in the human skill behind the equipment.

Electric arc welding consists in passing the current thru the material to be welded and a piece of wire attached to the opposite side of the circuit. In building construction, one wire from the secondary winding of the welding transformer is connected to the steel frame or beams, while the other wire connects thru a flexible cable to a fusible wire electrode held in an insulating handle. Heavy smoked goggles must be used.

One of the noteworthy achievements of the electrical engineer has been the recent demonstration of the practical application of electric arc welding to steel construction work.

An electric welding company needed a new building as an addition to its plant in Brooklyn and needed the building in a hurry. The electrical engineers were confident that such a building could be constructed by welding instead of riveting, and that there were specific advantages which would result from such a method of construction.

In the *first* place, the construction work could be done during twenty-four hours of the day without disturbing the people in either commercial or private life, because the process is absolutely silent, the nerve-racking noises of riveting being entirely eliminated. *Second*—The necessity for fabricating steel is entirely eliminated, and likewise the necessity of waiting several weeks until such parts should be fabricated and made ready for erection. *Third*—By electric welding joints of 100 per cent strength were made possible, as against the ordinary sixty or seventy per cent strength possessed by a riveted joint. *Fourth*—There was possible reduction in the actual weight of metal required in the various members, and *Fifth*—Actual tests had conclusively demonstrated that construction work by electric arc welding could be done at lower cost than by riveting.

Before the builders could proceed with their plans it was necessary to obtain permission from the various city building departments, and such permission would only be given if certain tests were made which would satisfy the building officials that a *welded structure* would be absolutely safe and would compare favorably in all other respects with a *riveted steel* framework. Certain samples of welded joints were requested for tests.

A specific sample of a lap weld of 1¼x⅜-inch bars, the ends lapt 1¾ inches and welded across the edges, was submitted. This welded sample was put in the machine in direct tension and developed the full strength of the bar, as the break occurred in the bar three inches above the weld, and developed a strength close to 60,000 pounds per square inch without affecting the weld. *These welds were cut across but showed no line of markation between the welding metal and the original bar metal.*

Another sample consisted of two angles set at right angles and lap welded at the intersection, the three-inch legs vertical (2x 3x⅜ inches). This sample was set in the machine so that there was a horizontal lever arm of 8 inches from the center of pressure to the center of weld and intersection, and developed a beam load of 11,375 pounds at the weld or a torsional stress of 91,000 pounds at the weld with no apparent distress to the weld. The angles buckled to such an extent that they failed to resist pressure.

WELDED STEEL TRUSSES FULFILL TESTS.

The tests of these samples were entirely satisfactory to the city building officials. Permission was subsequently given to proceed with the erection of the steel framework, but there was still another test to be made of the steel trusses of forty-feet span, which were to be used to sustain the roof. These trusses were of fan-type of design, and all members were electrically welded together, no bolts or rivets being used. The trusses were spaced twenty feet apart, supported by 8x8 II-beam columns 19 feet high; on the sides of these columns brackets were fastened to carry an overhead traveling crane of five-ton capacity. The weight of each truss was about 1,400 pounds, the top and bottom chords were composed of 4x5x⅜-inch tee irons and the struts were 3x2x⅜-inch angles, the purlins were 10-inch 15-pound channels.

The trusses were designed for a live load of 40 pounds per square foot, each truss supporting a panel of 800 square feet. They were tested at a load of 120 pounds to the square foot, or a total load of forty-eight tons on the two trusses. The load consisted of gravel in bags which were piled in tiers on planking arranged for the purpose. See photo herewith.

Readings were taken at different increments of the loadings for the deflection in the truss of members.

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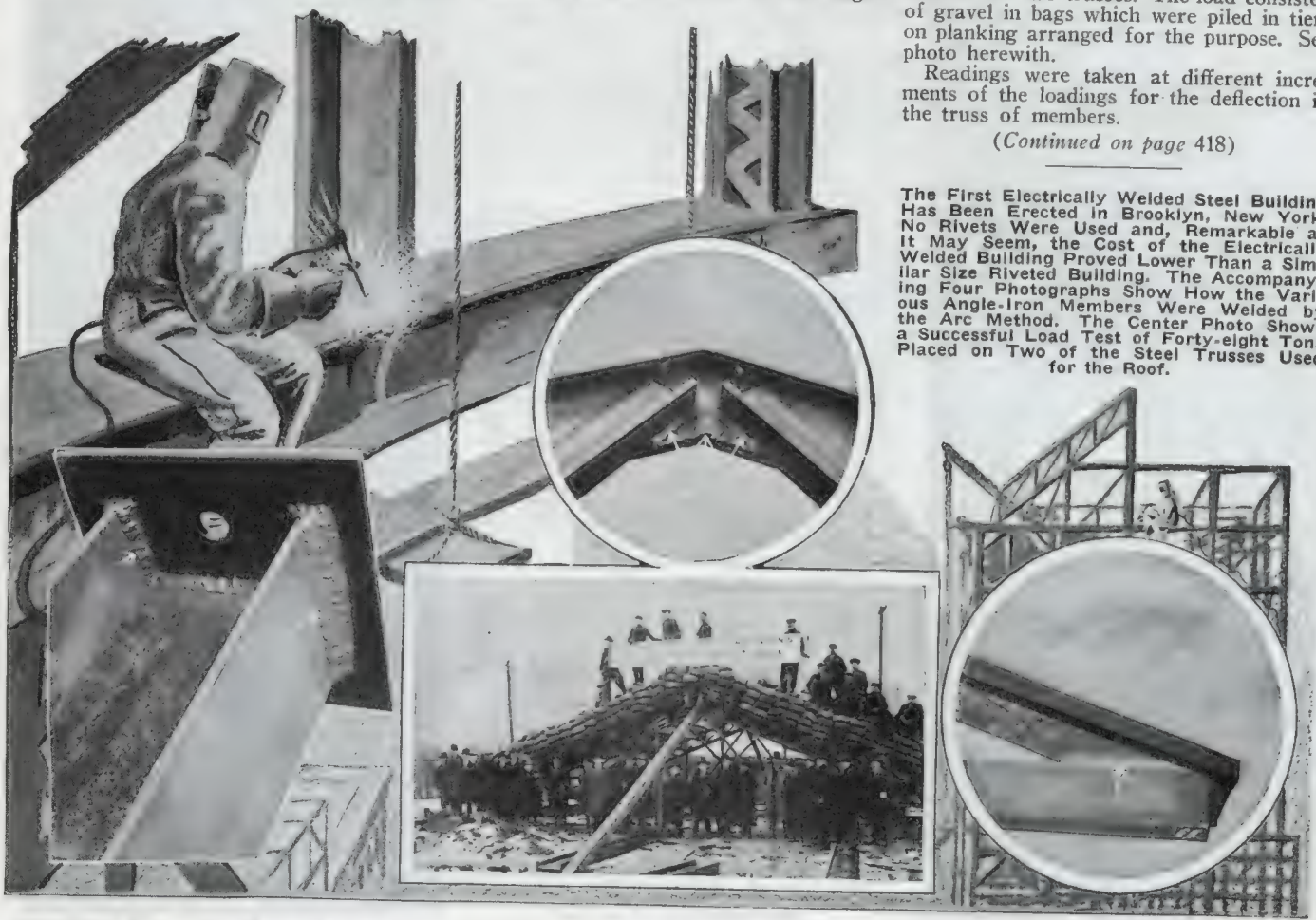
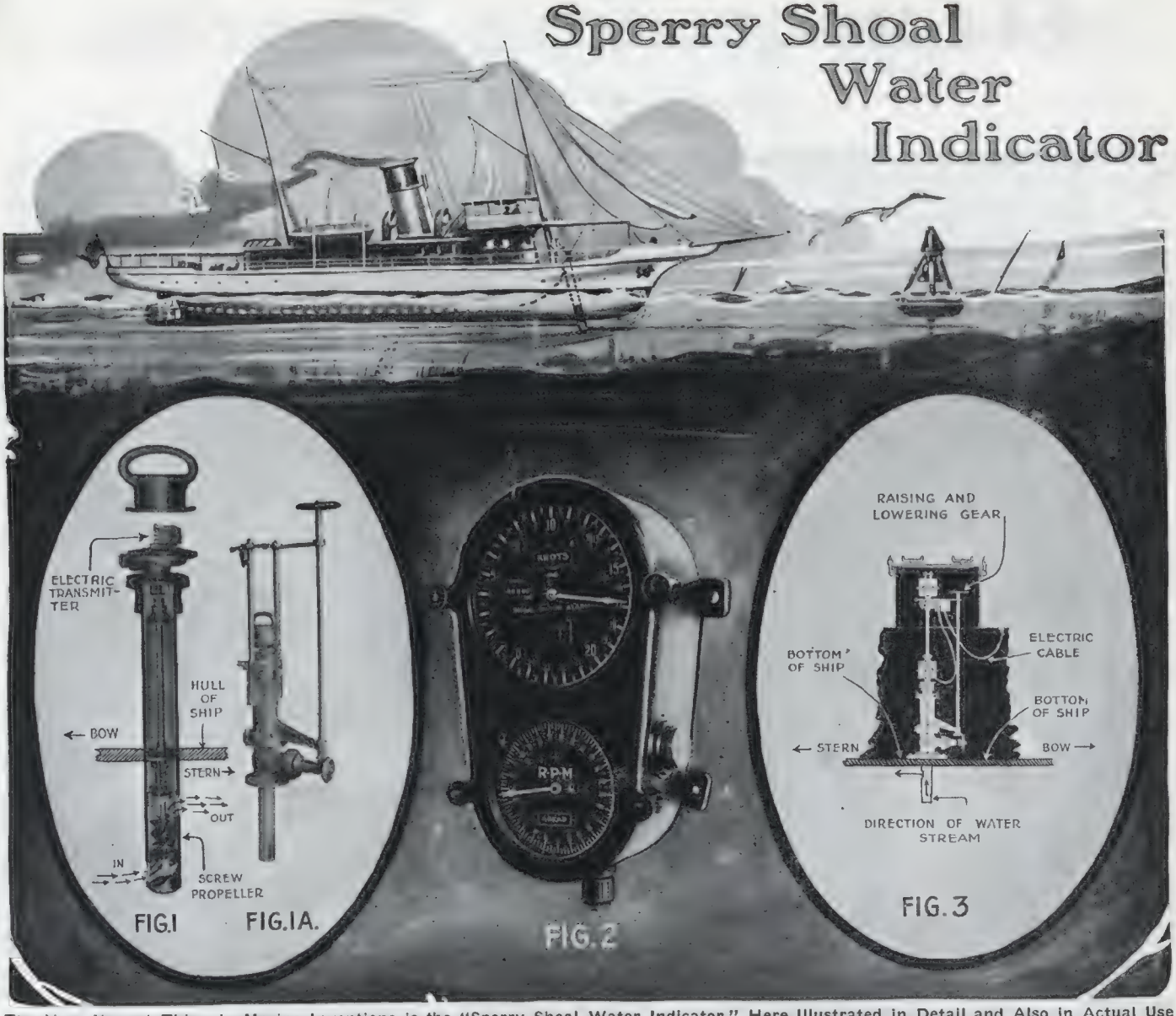


The First Electrically Welded Steel Building Has Been Erected in Brooklyn, New York. No Rivets Were Used and, Remarkable as It May Seem, the Cost of the Electrically Welded Building Proved Lower Than a Similar Size Riveted Building. The Accompanying Four Photographs Show How the Various Angle-Iron Members Were Welded by the Arc Method. The Center Photo Shows a Successful Load Test of Forty-eight Tons Placed on Two of the Steel Trusses Used for the Roof.

*Supervising Engineer, the Electric Welding Co. of America.

Sperry Shoal Water Indicator



The Very Newest Thing in Marine Inventions is the "Sperry Shoal Water Indicator," Here Illustrated in Detail and Also in Actual Use on a Large Yacht. The Principal Apparatus is That Shown at Fig. 1 and Fig. 1-A, and This is Mounted Well Forward in the Bottom of the Hull. The Arrows Indicate the Current of Water Passing Thru the Bottom of the Indicating Tube, and in Doing So, Rapidly Spins the Worm-Shaped Propeller Which is Connected with an Electrical Impulse Transmitter. Suitable Indicating Instruments (See Fig. 2) Are Mounted in the Pilot House and on the Bridge, and When a Predetermined Depth of Shallow Water Has Been Reached, an Electric Bell Announces the Alarm. The Instrument Can Be Set to Give an Alarm for Any Desired Depth of Water.

"WE are in shallow water" exclaimed the captain on a large Trans-Atlantic liner which was speeding on its way to the American shore.

"How is that possible when we are fully 500 miles from land?" asked an interested passenger.

"That gong on the wall just rang—that's my indicator. The question of whether or not shallow water has an effect upon the vessel traveling thru it to such an extent that the indicator will ring, has been positively affirmed by the new device called the Sperry Shoal Water Indicator and Log Transmitter."

Recent tests conducted in an effort to obtain information on this interesting subject have been carried out by the principal navies of the world during the speed trials of their respective ships. The outcome of all these tests have given to the world facts which have been nothing short of astounding.

Ships moving in shallow water at ordinary speed are greatly retarded, yet readings have been obtained which show that ships traveling at 30 *knots per hour,* have a seemingly higher rate of speed in a like amount of water, and that the resistance of the water is proportionately decreased with speeds above the figure here quoted.

Upon examining the graphs or curves for different depths of water showing retarding action and resistance on a vessel of ordinary speed, having an overall length of 50 feet and a mean draft of 25 feet, we find that a vessel traveling at 11½ knots in 75 ft. of water with 16 per cent resistance, will increase its resistance to 97 per cent when in 35 ft. of water, at which time its propeller speed will have to be appreciably increased. The instrument in question makes use of just those conditions heretofore outlined in a very unique manner.

A water velocity tube, about 3 inches in diameter, projects thru the bottom of the ship for about 12 inches, when the device is in operating condition. There are openings at opposite sides, one facing the bow and the other the stern, to allow for a flow of water thru the tube entering one opening and out the other. This takes place whenever the ship is in motion, and during the course of flow, advantage is taken of the flowing stream by making it turn a helical propeller located in the central lower portion of the projecting tube. See Fig. 1.

The shaft of this propeller is geared to another shaft, which in turn is continued upward to the end of the tube, where the small electric transmitting unit is located. Impulses from this unit affect an indicating instrument located in the ship's pilot room and in any other parts of the vessel where additional instruments may be necessary or desirable.

The tube itself can be raised into the hull, in which case a valve is actuated so as to prevent water from flowing in. All joints are made watertight and at no time can any perceptible amount of water flow into the ship, and inasmuch as the space occupied does not exceed 50 inches in height, it is really quite a negligible quantity in a vessel of even small size.

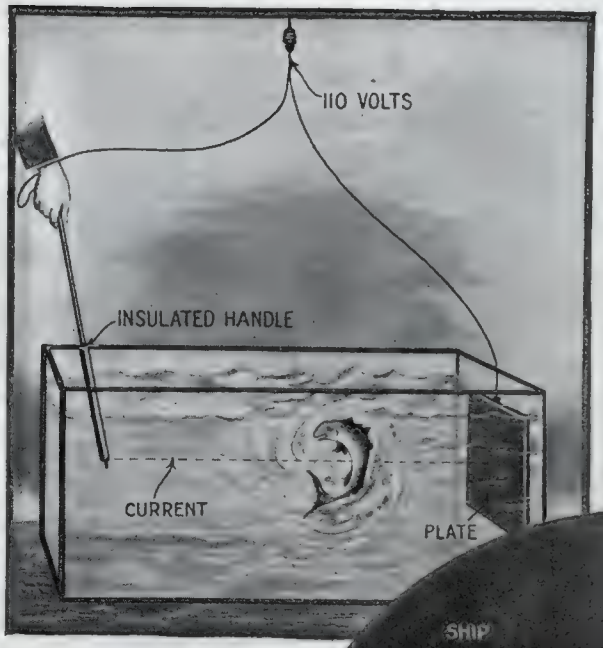
The *indicator and shoal water alarm* which is placed in the pilot room, is composed of two dials, see Fig. 2. On the upper dial, a reading of the actual speed of the vessel in knots is shown by a pointer. In a small slot numerical indication of the total knots traveled can be readily determined, and in a similar slot, we obtain an inference of the trip distance traveled to great exactitude, allowing for a fractional knot reading down to one one-hundredth of a knot. A contact for shoal water alarm is located at the lower center. In the lower dial a slot needle indicates whether we are going *ahead* or *astern.* In addition, an adjustable indicator shows when the ship

(*Continued on page* 456)

Electrocuting Sharks

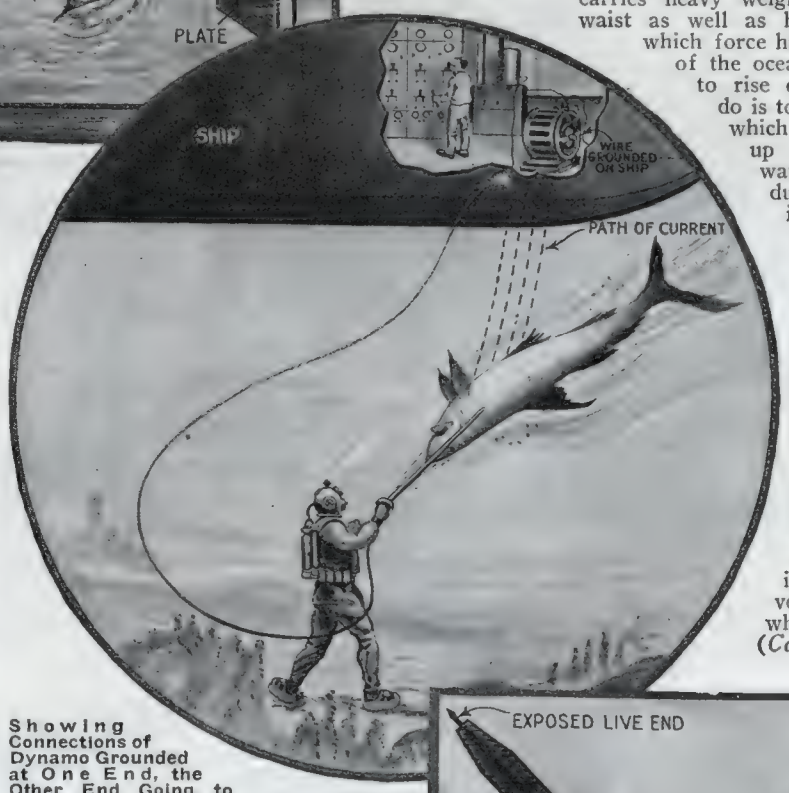
By H. GERNSBACK

SOME ago, in our Sept. 1916 issue, the writer publisht an account of a new method of electrocuting sharks whereby electric cables, hanging from the sides of a boat or ship, were baited and thrown into the sea. When the shark tried to devour the bait, the current was turned on. Due to the fact that the shark was in a highly conducting medium—sea water,—and as one end of the dynamo was grounded on the boat's plates, the shark would be instantly electrocuted. Of course, such a system does not eradicate the shark pest, as sharks do not always come to the surface, nor do they always take advantage of the bait.



Experiments Showing How Fish is Affcted by Electrical Current Without Wire Touching Him at Any Time.

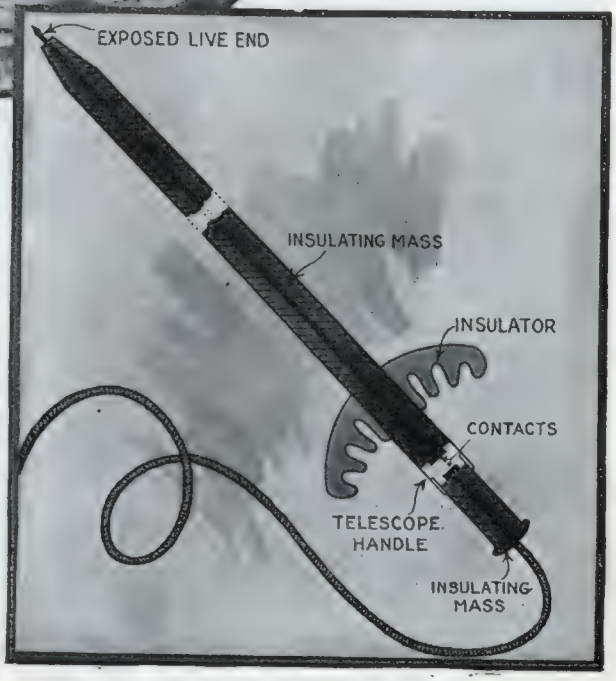
In the South where the sharks are numerous and where the pearl fisheries and the sponge industry thrive, many casualties occur yearly due to the sharks attacking the divers, and there is no method in use now which safeguards the divers. With this idea in mind, the writer advances an idea which is the subject of our cover illustration. In other words, we take the battle right into the sharks' domain itself. We do not wait until the shark comes up so that we can pot at him, or otherwise destroy him, but we hunt right in its own habitat, underneath the surface of the ocean.



Showing Connections of Dynamo Grounded at One End, the Other End Going to Cable, Manipulated Thru a Pole by Diver.

Several curious things occur when we begin electrocuting sharks or fish in this manner. Actual tests made by the writer have brought out the following:

In our illustration No. 1 is shown a glass tank containing a fish, a grounded plate and a handle carrying a wire, the end point of which is bare. If we turn on the 110 volt current *without at least touching the fish,* he will begin to swim around frantically, altho no wire or plate touches him. The reason is of course that the current from the wire tip passes from the salt water to the plate, and inasmuch as the fish is right in the path of the current, a certain amount of current naturally must pass thru his body. The closer the live wire comes to the fish, the stronger the effect will be, and if we come within about two inches from the fish, it often happens that the latter will jump clear out of the tank, as has been demonstrated in these experiments. Small fish when touched by the wire will be electrocuted almost instantly with 110 volt current. Of course, here the problem presents itself that we cannot possibly touch the fish by means of the live wire, because as mentioned above as soon as the wire comes near him, the fish will try frantically to clear out of the path of the current. Hence, it is necessary to switch off the current until the dead wire actually touches the fish. Then as soon as contact is establisht, the fish will of course be electrocuted. Upon these experiments the shark electrocuting idea is based.



Construction of Electrocuting Pole, Showing Live End and Insulating Shield to Protect Diver.

In practice the divers are preferably provided with self-contained compressed air apparatus strapped to the back and front as shown in our cover illustration. Such apparatus are on the market already and can be bought now. The idea of using self-contained air apparatus is obvious because it gives the diver more freedom of action, and does away with dangerous air pipes and life lines. Furthermore, inasmuch as high tension cable is used, it would not be wise to use these air and life lines as will be readily understood by a moment's reflection. On board of the mother ship from which the divers descend, we have the usual high tension dynamo of about 1500 to 2000 volts, one side of the dynamo being grounded. The other side connects to the high tension cable which plays out to the diver as he descends. The diver himself carries heavy weights strapt around the waist as well as heavy lead shoe soles, which force him down to the bottom of the ocean. In case he wishes to rise quickly, all he has to do is to disengage the weights which will make him shoot up to the surface of the water with great speed due to the air contained in the tanks which gives him great buoyancy.

At the end of the rubber insulated electric cable we find a sword-like pole, which is well insulated, and which may be made of bamboo or any other material that is strong and light. The electric cable runs carefully insulated thru the entire length of the pole but is not insulated at the very end. A small point which is to pierce into

(*Continued on page* 424)

Marvels of the Ear

By JOSEPH H. KRAUS

IN a previous discourse on sound in this journal we have learned of several of the more novel surprises in the world of sound, which not only interest everyone, but which are at the same time not generally known. Perhaps no more wonderful study has ever presented itself than the subject of "how we hear"—and even to-day this function is not very clearly understood.

How We "Hear"

The auditory organs themselves are divided into three parts, *external, middle* and *internal ear.* The foremost one we shall not consider at the present time to any great extent, because it serves only a slight function in hearing. This consists of the ear (the external ear or the one which we see) and the tube or canal entering the side of the head up as far as the drum. It can be *entirely absent* and not affect hearing except that localization of the position from whence any particular sound comes is lost considerably.

Sound, as has been said, is of vibratory nature, and when impinging on the drum of the ear, medically known as the *tympanic membrane,* we get a rise and fall of pressure; thus an increase in pressure will force that membrane inward and the fall favors its outward motion.

In contradistinction with other membranes this membrane in the ear has no vibratory sound of its own; in other words, *has no period.* If it had one, it would undoubtedly vibrate in resonance with some particular sound to which it is attuned, and we would get a false impression of intensity. However, being made cone-shape and having a convexity outward with its fibers of construction running circularly and radially and in addition to the fact that it is tightly stretched, it follows that each and every portion of the cone will have a different period of vibration and the whole diafram will be aperiodic.

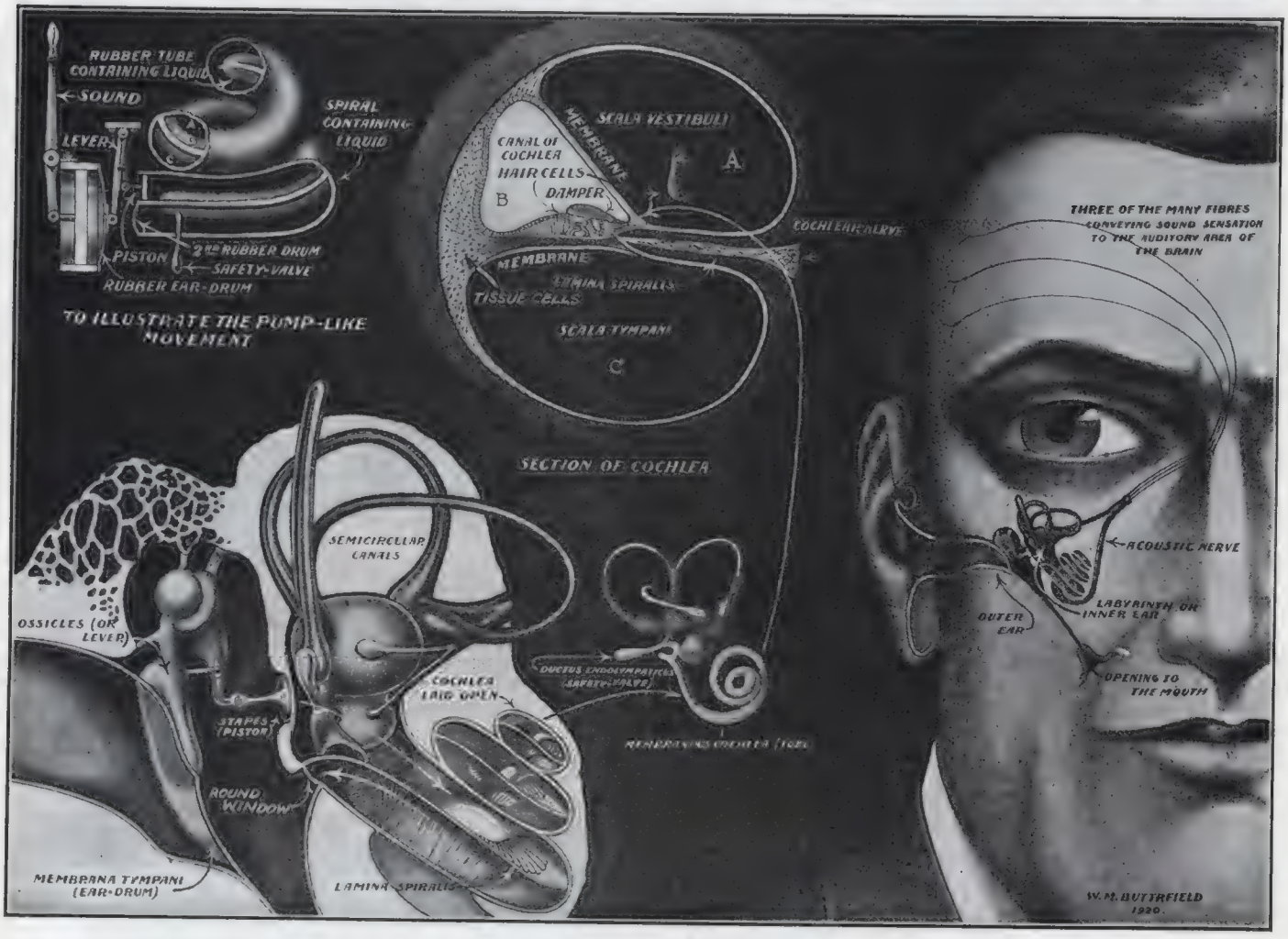
BROKEN EAR DRUM DOES NOT PRODUCE DEAFNESS.

Many people have thought that the ear drum, if broken, produces deafness. Strange as it may seem, such is not the case, and medical authorities have establisht the fact that even the entire absence of the ear drum will not produce deafness, altho it does effect keenness of perception of auditory sensations of a slight nature.

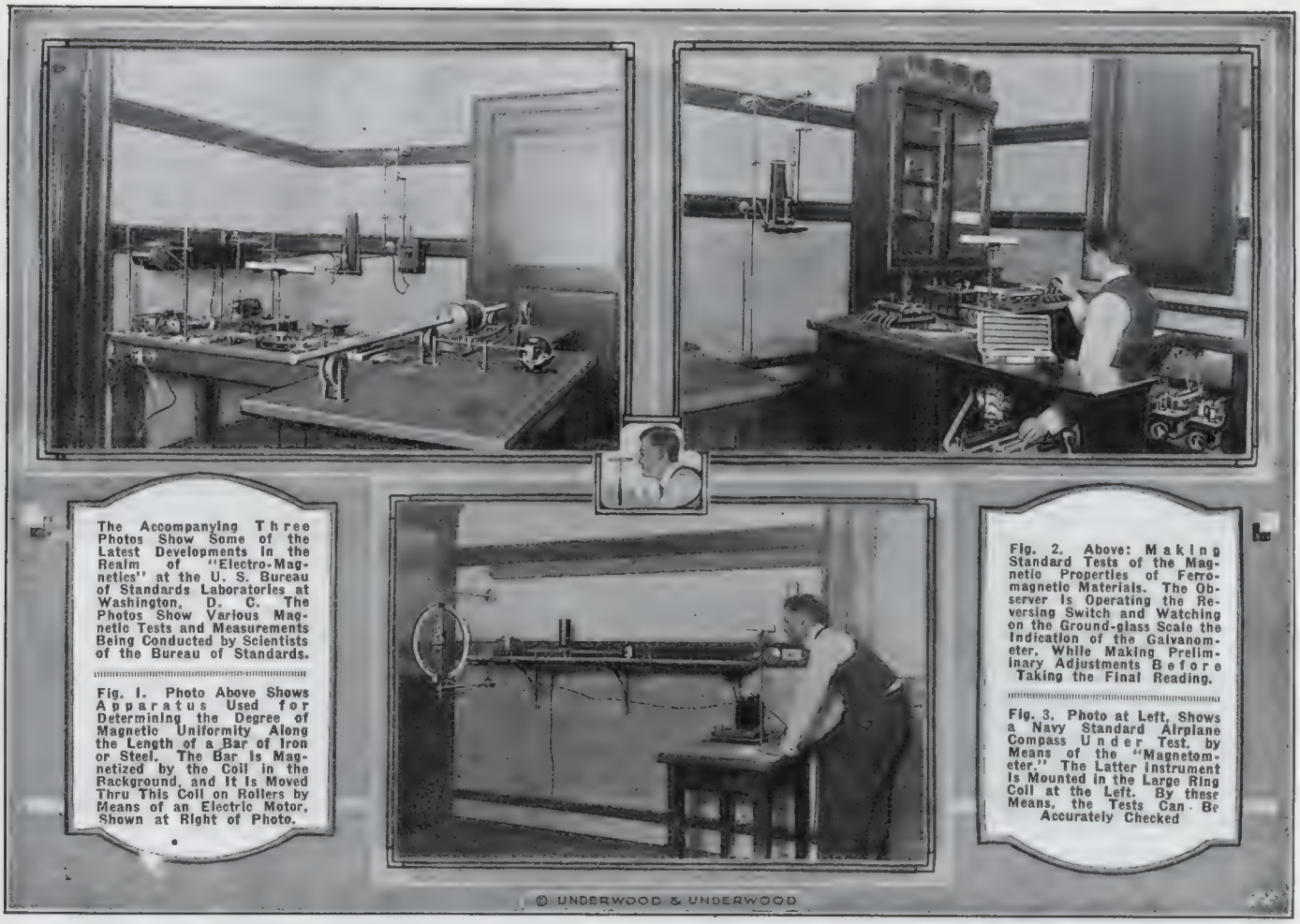
The function of the canal is merely to assist in keeping out insects and dust, being lined with hair and also to maintain an even temperature at the drum. Between the drum and the internal ear is a chain of tiny bones situated in the intermediate division; this division is called the *middle ear.* These bones connect the large membrane or drum with a small membrane 1/20 its size.

This latter membrane has been termed the *oval window* (fenistra ovalis), and as our diagram indicates, the bones themselves are combined into a powerful lever action which multiplies the force of the drum movement. This movement tho in its amplitude is diminisht two-thirds; the pressure at the end (oval window end) is therefore naturally increased one and a half times thru the bone action alone.

(*Continued on page* 422)



The Above Illustration Gives Us a Representation of the Action of the Ear Which Will Be More Clearly Understood by the Analogy at the Upper Left-Hand Corner. Here We Find a Spiral Tube Divided Into Two Parts by Means of a Rubber Tube and a Partially Solid Wall, Each Filled With Liquid. The Upper Part Communicates With the Lower at the Top of Its Spiral. When Any Movement of the Pump Handle Is Produced, the Rubber Ear-Drum Moves a Certain Definite Distance, Which Is Amplified Thru the Lever Arrangement and the Smaller Cross-Sectional Area of the Second Piston. This Compresses the Liquid Contained in the Upper and Lower Spiral Tubes Communicating That Pressure to the Lower Part Where the Second Rubber Drum (Round Window) Bulges Outwardly. The Pressure Also Has an Effect Upon the Rubber Tube Compressing the Liquid Within It and Sometimes Causing a Flow Into the Safety Valve; the Rubber Tube Itself Is Made Up of Flexible Walls, the Bottom Part of Which Has a Series of Strings Along Its Length. Its Strings Are Thus Caused to Vibrate In This Way Exciting Little Cells Upon Them and Giving Us the Sensation of Sound. In the Diagram to Its Right We See the "Rubber Tube" Marked "Canal of Cochlea." The Strings Are Located In the Lower Membrane With the Hair (Sensitive) Cells Upon Them, and a Damper to Prevent Excessive Vibration. By Comparison With the Anatomical Diagram, the Analogy Will Be Readily Seen.



The Accompanying Three Photos Show Some of the Latest Developments in the Realm of "Electro-Magnetics" at the U. S. Bureau of Standards Laboratories at Washington, D. C. The Photos Show Various Magnetic Tests and Measurements Being Conducted by Scientists of the Bureau of Standards.

Fig. 1. Photo Above Shows Apparatus Used for Determining the Degree of Magnetic Uniformity Along the Length of a Bar of Iron or Steel. The Bar Is Magnetized by the Coil in the Background, and It Is Moved Thru This Coil on Rollers by Means of an Electric Motor, Shown at Right of Photo.

Fig. 2. Above: Making Standard Tests of the Magnetic Properties of Ferro-magnetic Materials. The Observer Is Operating the Reversing Switch and Watching on the Ground-glass Scale the Indication of the Galvanometer, While Making Preliminary Adjustments Before Taking the Final Reading.

Fig. 3. Photo at Left, Shows a Navy Standard Airplane Compass Under Test, by Means of the "Magnetometer." The Latter Instrument Is Mounted in the Large Ring Coil at the Left. By these Means, the Tests Can Be Accurately Checked

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The Electro-Magnet in Science

THE accompanying photographs illustrate magnetic tests and measurements being conducted at the Magnetic Laboratory, Bureau of Standards, Washington, D. C. Investigations are in progress to determine to what extent these laboratory methods can be employed to advantage in investigational and commercial work for the detection of flaws or chemical segregations in iron and steel bars, for the measuring of core loss in all electrical apparatus, and for any problem connected with the properties of ferro-magnetic materials.

STANDARD MAGNETIC PERMEAMETERS.

Standard tests of the magnetic properties of ferro-magnetic materials are made by means of the compensated double-yoke apparatus shown in this photograph. The observer is operating the reversing switch and watching on the ground glass scale the indications of the galvanometer, while making preliminary adjustment before taking a reading. There are several sets of magnetizing coils for the measurement of various sizes of specimens. The bars in the box in the foreground are standard bars for checking measurements. Figure 2.

MAGNETIC UNIFORMITY MEASUREMENTS.

If a bar of steel is chemically and mechanically uniform along its length, it is also magnetically uniform, and consequently any variation in chemical composition or mechanical condition will be indicated by a corresponding variation in its magnetic properties. Figure 1.

For "September"

Liquid Air,—What It Is, and What It Does. Illustrated.

Can We Live on an Electric Diet? A French Experiment.

The Fourth Dimension and Hyperspace, by Frank M. Gentry. Popularly explained with diagrams and pictures.

Big Rotogravure Feature Section. Don't miss it!

Hammering Electrons Out of Matter. By Harold F. Richards, Ph.D.

Eclipses, What Are They? By A. M. Harding, Ph.D.

Archimedes, the World's First Inventor. In Rotogravure.

How Big Are Molecules? A popular exposition. Illustrated. By Rogers D. Rusk, M. A.

Murderous Rays—a gripping scientific story—written by a Scientist. By Harold F. Richards, Ph.D.

The apparatus shown in the photograph is used for determining the degree of magnetic uniformity along the length of a bar of iron or steel. The bar is magnetized by means of the horizontal coil thru which it is past on rollers driven by an electric motor. Variations in magnetic permeability are indicated by deflections of a sensitive galvanometer connected to test coils surrounding the specimen and mounted inside the magnetizing coil.

In the photograph the indications of the galvanometer are being recorded on a photographic film mounted on a drum and rotated at a constant speed.

TESTING THE STRENGTH OF COMPASS NEEDLES.

One test that may be applied to magnetic compasses is to measure the strength of the magnetic needles, which is called the "magnetic moment." The measurement is made by noting the deflection of a small suspended magnetic needle when the compass to be tested is placed opposite to it. This deflection is indicated on a ground glass scale by a spot of light from an incandescent lamp which is reflected from a small mirror mounted on the suspended needle.

In the photograph, a Navy Standard airplane compass is being tested. The measuring instrument, "magnetometer" as it is called, is mounted within a ring upon which is wound a coil of wire. By means of a measured electric current in this coil, the instrument is calibrated, so that it is readily possible to tell just what value of magnetic moment corresponds to a certain deflection on the scale. Figure 3.

First Electric Locomotive

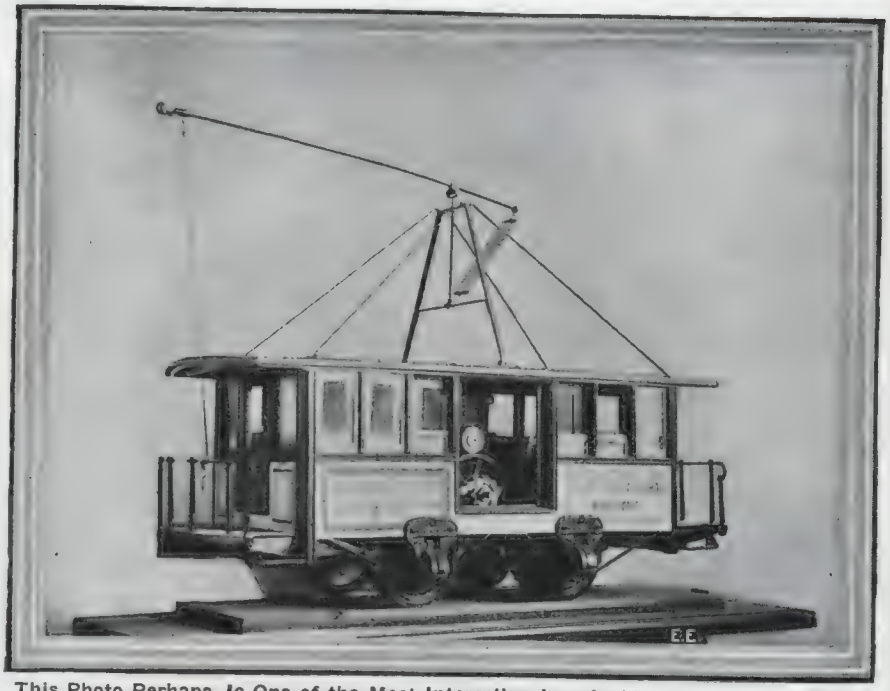
By HARVEY H. SMITH

Only thirty years ago the first electric locomotive in the United States, and so far as is known, in the world, designed for hauling freight made its trial trip from Ansonia to Derby, Connecticut. This locomotive, which was the forerunner of the huge electric motors in use to-day, was considered a marvel of engineering achievement at the time of its introduction.

The original locomotive which is now in the Hartford barns of the Connecticut Company, and a model of which appears in the accompanying photograph, was constructed by the Pullman Palace Car Company and weighs 35,000 pounds. The electric equipment, consisting of a 76 H.P. motor, was manufactured by the Depoele Electric Manufacturing Company.

The first trial trip took place May 1, 1888, over the Ansonia-Derby, Birmingham route. In ordering the car it had apparently been forgotten that a low railroad trestle existed near the Derby dock, for it was found that the body of the car was too high to allow clearance. The roof was accordingly removed and a collapsible trolley frame improvised for the initial trip. On one side of the passage under the railroad trestle was kept a box containing a flexible insulated cable which was connected to the trolley wire, the free end being a brass contact piece. When the collapsible frame was lowered to the roof, the plug was inserted in a socket contained in the wooden block on top of the car near the base of the trolley frame, and the cable was paid out, thereby providing power for the car to operate under the trestle.

Laminated copper brushes were used, and as the brush holders would sometimes work loose, *the motorman usually stood with his hand pressing on the handle of the brush holder to secure good contact!* As a result of sparking the ends of the brushes frequently fused, making it necessary to trim them with a pair of shears carried for the purpose. Think of it!! In case the locomotive moved backward unexpectedly the ends of the brushes would catch in the commutator bars and bend over, also necessitating trimming the copper before proceeding.



This Photo Perhaps, Is One of the Most Interesting Imaginable, Showing As It Does, the Exact Model of the First Electric Locomotive Built in the United States, and Probably the First Practical Engine of Its Type in the World. Its Trial Trip Occurred in 1888. Its Initial Journey Was Hailed as a Huge Success, at the Time.

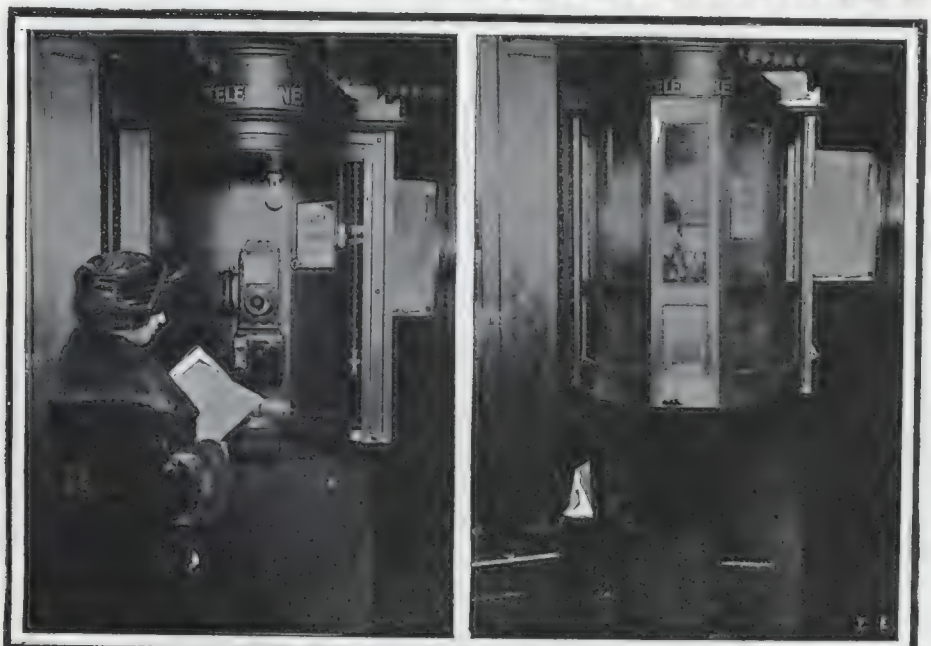
Lightning arrestors had not been introduced and burnouts often resulted from electric storms. So frequent were the delays from this source that the management adopted the practise of suspending operation during storms. The freight motor had the distinction of being reversible and therefore could be operated from either end, a feature which the passenger cars did not have at this time.

The motorman's position when operating was inside of the body, where he stood in a pit or depression in the car floor, a provision necessary to give him "head clearance."

The only untoward event of the first trip was a derailment half way to Derby junction, but no serious delay resulted and the management considered the first trip a "huge success." The Ansonia *Sentinel* said of the trip: ". . . 'All aboard for Derby,' someone shouted and a man seated on the top of the car swung the traveler around to the wire, the current descended, and away sped the car like a thing of life."

Better Telephone Booths

By K. H. HAMILTON



The Latest Idea in Telephone Booths Is Here Illustrated, and Instead of Having to Step Into a Half Clean, Full Length Booth in the Form of a Closet, You Simply Step Into This Open Semi-Circular Frame, Pull a Cord, and the Half Length Booth Closes Around You. Another Pull of a String Opens It.

The atmosphere of a telephone booth on a heated day in summer will be more bearable when the new design comes into general use. It is operated by a string, and hangs from the wall enclosing the user to about the hips of an average height person. The bottom is not closed as is seen but permits a free circulation of air at all times.

In operation a user finds the telephone fully exposed and the booth door rolled back out of sight. Within two signs reading—"Please pull cord," are in evidence. The first use of cord closes the booth door around the user, the second permits it to roll back into its original position when not in use. The door is a circular glass one working easily on three-point ball bearings.

The new booth has many advantages to recommend it. First, it requires less material to build, and second, less space for its installation. Dust and dirt that naturally collect on the floor of the closed booth is avoided as the floor is readily accessible to the scrubber of the regular room floor where booths hang from the wall.

Booths of this description are being used in Boston and several other cities, and have been invented by a regular telephone man, Mr. John J. Barry, a telephone manager in an Eastern city.

Jules Verne

The World's Greatest Prophet

By CHARLES I. HORNE, Ph. D.

Professor, College of the City of New York

DO the scientific students, young and old, of the present generation realize one half of what they owe to that remarkable master of the last generation? We who as boys in the 1860's and 70's were brought up on Verne's stories, we who caught the first vivid glow, who gave the first enthusiastic scientific response to his romances, we know all that the world owes him. But has the new generation forgotten?

Jules Verne was the world's greatest scientific prophet. He was its greatest inventor, not in the immediate sense of having laboriously worked out each practical step of some new machine, but in the broader sense of having conceived, foreseen, planned out the general road along which advancing science was to make its way. That was Verne's real service. He illumined the path; he inspired a thousand thousand of us to take the road, to build as he had urged. And we have justified his faith, we have reached his goals. Not all of them—that is why I am speaking now. I would call the attention of our world not only to the Verne visions which have become our facts, but also to those which still lie beyond.

The master himself in his older days—he died in 1905 at the age of seventy-seven—compared his own art with that of the writer whom he regarded as the ablest of his followers: H. G. Wells. He said that Wells looked a thousand years ahead and, soaring with imaginative fancy, wrote of all that mankind might possibly achieve; whereas Verne himself had always been careful to keep in touch with the actual science of his day, to study it closely and then take just the one step forward which he was convinced science was about to take. This explains exactly where Verne's genius lay, why his prophesies have so many of them come true and why today we look with special curiosity on those which have not yet been achieved. We ask ourselves not "Will they be achieved?", but only "How soon?"

Among those Verne visions which have already materialized, doubtless every reader knows "Twenty Thousand Leagues Under the Sea" and its sequel "The Mysterious Island," with their romance of Captain Nemo and his submarine. There were no submarines when that tale began in 1870. The first successful one was developed by the American inventor Lake in 1897, and only with the remarkable "supersubmarines" constructed in the last year of the Great War have we really paralleled Captain Nemo's boat.

Similarly in "The Steam House," publisht in 1881, the master planned an automobile such as our five ton autotrucks of today are equalling. In that first tale of the self-propelling carriage, Verne depicted ordinary steam as his motive power; he had not conceived the greater energy of the gas-driven machine. Later, however, in his "Master of the World" he uses gas and electricity as the sources of power of an automobile, giving it just about the speed, a hundred miles an hour, which our racers show in the daring contests of today.

So too with the air-machine. In "Robur the Conqueror" publisht in 1886, Verne not only pictured the conquest of the air, as it was to be accomplisht some twenty years later, he even foresaw the struggle between the two great types, the "lighter than air" and the "heavier than air," and he awarded the triumph where the Great War has placed it, with the "heavier" machine. In the war we saw, as his vision had seen, the unwieldy "dirigible," the Zeppelin, prove itself of little value compared to the easily controlled "plane," the Sopworth bomber and the Curtiss sea-plane.

In the aerial realm as in the sea and land vehicles, Verne developed his ideas with time. The air-machines in "Robur the Conqueror" pale before the marvelous machine depicted in his later book "The Master of the World." Here the earlier hero, Robur, reappears with an invention which travels equally in the air, on the land, on the seas, and under the seas. We are just stumbling toward that development today. The seaplane travels on the water or in the air; we have a new automobile which seeks the aid of wings. Last month our scientific papers were talking of a practical water-automobile, or equal sea and land traveller. So step by step we are overtaking the master. He is no longer with us to point yet on and ever on.

Electricity is prominent in all of these prophetic books. Verne saw well the future part it was to play. Electric machines, some not wholly realized yet, form the main source of light and power in his visioned world. In some books he pursues electrical uses into yet further details. The "Castle of the Carpathians" centers its story on the invention of a phonograph before Edison had made one for us. The "Floating Island" depicts dozens of electrical and mechanical devices. It reaches beyond the telephone and describes a "telautograph" by which electric messages are written, and a "kinetograph" by which electric pictures are drawn.

As to chemistry, Verne's "Dr. Ox's experiment" foreshadows the value of oxygen gas as a stimulant and reviving force. His "Star of the South" deals with the making of synthetic diamonds. His "Underground City" takes us into the miner's world of coal and its dangerous gases. Comprest air and comprest food are among the master's earliest conceptions.

Most marvelous perhaps of all are his stories of great guns and high explosives. In the World War when Germany suddenly bombarded Paris from a seventy mile distance, many scientists declared the thing absurd, impossible. Paris, they said, had been bombed again from air machines, not bombarded by a gun. They should have known their Jules Verne better. His first concept of such a cannon, hurling a projectile at once above the atmosphere and so escaping friction thru the main distance of its flight, was developed fantastically in his "Trip to the Moon." We have not yet duplicated that giant gun which shot the voyagers forth beyond our planet's gravitation; but our scientists now tell us that we could do so—if it would be of any "earthly" use.

More nearly in line with the actual developments of the War were the explosives pictured by the master in his "For the Flag," a truly illuminative work, and in his "Purchase of the North Pole." But most amazing of all in its preknowledge of guns and explosives and destructive gases, and also of the human forces behind them, was his "Millions of the Begum." When in the years after Verne's death I was called on to edit a definitive edition of his works, I felt it necessary to apologize for the "Begum" book with its hideous and awful picture of the German scientist, so ready in destruction, so exact with his mechanisms, so brutal in his soulless use of them. Even with the master's word for it, I could not then believe in such a German mind. You will understand the World War better if you reread the vision of it in the grim and terrible prophesies of this, Verne's *ugliest* book, written decades before the World War.

The present brief review can not cover the entire field of Verne's romances. In the realm of travel and adventure he was as preëminent as in the realms of science. Witness, for instance, his "Round the World in Eighty Days," of which each daily installment was cabled word for word from France to America that an eager public here need not wait a steamer's passage and thus remain so much behind their French co-readers. Or witness his "Michael Stroghoff," which became the great dramatic spectacle of the age.

In his "Desert of Ice" he carried us to the North Pole and made us see its bleak and empty world very much as Peary has since done. He built a story also on the South Pole. "The Sphinx of Ice." Here, however, he avowedly carried on a fantasy begun with our great American romancer, Poe; so Verne was pledged to Poe's beginnings and visualized for us a southern world of heat and wild peoples and electrical mysteries wholly foreign to the bleak land Shackleton and other explorers have since explored. The "Sphinx of Ice" thus stands alone as the one Verne book which time has contradicted.

Of still further reachings into the unknown, on which man can not yet render a verdict, were Verne's "Journey to the Center of the Earth," which no man seems soon likely to achieve; and his "Off on a Comet," which takes the reader to our sister planets. Yet it is notable that in both these books, as in the "Trip to the Moon" and its continuation, the "Tour of the Moon," later knowledge has followed the lines suggested by Verne. Here again instead of playing with idle fantasies of unknown worlds, the master studied all we know of other planets and our own, and keenly judged what conditions visitors to the farther worlds would be most likely to encounter. His genius searched ever for

(*Continued on page* 421)

THERE is hardly a civilized human being today who has not heard of Jules Verne and his marvelous scientific prophecies, a great many of which have come true. He forecasted the submarine, the airship, the phonograph, and dozens of other inventions long before the respective inventors had ever dreamed of them. The accompanying article by Professor Horne is particularly valuable for the reason that Mr. Horne not only has translated a good many Jules Verne's books from the French into English, but has also edited the only complete English set of all of Jules Verne's writings and for that reason is pre-eminently fitted to do the great subject justice. We know that our readers will appreciate this very important article.—EDITOR.

AEROPLANE
DIRIGIBLE
MOON ROCKET
LONG DISTANCE GUN
MOTOR TRUCK
SYNTHETIC DIAMONDS
AROUND THE MOON
PHONOGRAPH
ADVENTURE BOAT SAINT MICHEL
VERNE'S HOME
Jules Verne
THE WORLD'S GREATEST PROPHET
TELAUTOGRAPH WRITES AT DISTANCE
KINETOGRAPH
SUBMARINE-AEROMOBILE
VERNE'S TOMBSTONE
PAUL

Water—The Elixir of Life

By WILLIAM M. BUTTERFIELD

WOULD you, gentle reader, wish to be a modern Ponce de Leon and sail away, as he did, in a high-pooped Spanish galleon made gay with silken streamers, embroidered gold and painted sails; would you, surrounded by a choice band of jolly noblemen, sail in this romantic craft across summer seas to the mysterious New World and the palm-fringed shores of Bimini; would you, with this gallant company, seek on the planes of this garden of the seas for the Fountain of Perpetual Youth; would you, a nerve-racked, supersensitive modern citizen, wish to be young again and live happily evermore?

Would you? Of course you would! For surely, deep down somewhere in your mind, lies this inherent longing, fully as old as the race, or born beneath the cinnamon boughs, eight thousand or more years ago, as Hindoo sages taught their Brahminical followers, that a Fountain of Youth existed somewhere. This fountain, our modern publicity experts place in actual location in modern mineral springs, such as at Baden-Baden, Carlsbad or the Hot-Springs, and a credulous public accepts the romance as willingly as the Brahminical adepts did on their famous journey across the seven rivers of the Ponjaub; such is the great desire and longing for Youth.

The ancient philosophers had a belief, quite like the modern one you will have to admit, that to see, or at the most taste or bathe in the waters of this mysterious fountain, was sufficient to bring perpetual youth, health and vigor to any one fortunate enough to reach it. Ponce de Leon set out on his memorable pioneer tour with this belief, and millions of the more fortunate of us have been doing the same thing, ever since then. Yet it is, strange to relate, a fountain as mysterious and illusive as ever, for there are no authentic records of permanent transformations, or even cures having been made during this age-long search. Would you like to know why? I will try to tell you, and at the same time help you discover the *real* fountain of health, if not of perpetual youth.

There actually are only a few pounds of water and a little charcoal that constitutes the difference between the vigorous body of a youth with a round rosy face, and the shrunken shank and withered features of an old man,—yet you cannot obtain the difference from a magical fountain of youth; Nature never does Her work by performing what man is pleased to call "miracles," miraculous as that work may seem. We smile at the hymns of the Vedas for portraying their deities as living upon the earth for life-times, extending over hundreds of thousands of years, as in the case of Vishnoo,—yet listen respectfully to any physician of ordinary reputation express, with positively no proof, a belief that the men and women of our time should live 200 years. And we believe, tho he fails to give a remedy that carries a universal guarantee, to insure those who try his plan, that they will surely reach that "allotted time." The pronouncement voices, you see, the same old desire that is as prevalent; and we cannot help believing.

It may seem strange to the reader why, thru all these years, the world has been seeking some peculiar kind of water, but this is not mystifying when we consider that the average adult, say of average weight, is composed of 138 pounds of plain water and only 12 pounds of "highly organized" man or woman, just 12 pounds of clay and 6 pails of water. Water is, as any one can see, of considerable importance in our physical makeup, but the old Hindoos, Ponce de Leon or our average citizen, is as ignorant of this well-known fact as can be; yet each sought, or is seeking for help from water; this is the strange part of the whole story.

Pushing the investigation still farther, we find that the anatomy of man, tho liberally irrigated, is comparatively solid as animals go, for there are innumerable others more bountifully supplied with *aqua purae*. A species of sun-fish often caught on the shores of Long Island, and sometimes weighing 30 pounds, contains only ½ ounce or less of flesh; and the common jelly-fish is but 10 parts solid to 1,000 parts water. Vegetables are almost all water, so that the food a man eats adds to his body supply. Thus, besides the 3 pints of water (or half a ton a year) that an adult must drink daily to supply the ordinary requirements of the system, they take into the body still more in their food, in about the following proportions:

Bread, cake, pies, pastries, etc., are more than half water, apples are 81 per cent. water, pears and peaches 89 per cent., musk and watermelon 98, grapes and berries 99, potatoes 75, carrots 83, beats 88, cabbage 92, trout 81, lamb 73, beef 74, and veal or pork 75. The cigar a man smokes is 30 per cent. water, the match he lights it with contains it both in the stick and the head, and the combustion of both match and cigar

(*Continued on page* 417)

Water Is the Savior of Man's Earthly Existence—In a Material Sense. Our Food, as Clearly Shown in the Author's Illustration Above, is Mainly Composed of Water. The Black Miniatures Within Each Specimen Represents the Relatively Small Solid Portion of Each. The Balance is Water.

Electric Household Wrinkles

When the Janitor Goes on a Strike, or When the Coal Is Too Low in the Basement to Start the Water Heater, This Immersion Heater Which Heats a Whole Dishpan of Water in a Jiffy, Stands Ready to Help. It Has a Heating Surface Ten Inches in Diameter.

An Illuminated Letter Basket for the Hall Table. The Lamp and Shade Are Hung Over the Handle of the Basket and the Light, Falling on the Basket, Tells "Father" the Minute He Enters the Door Whether He Has Any Mail or Not.

By Adjusting a Lamp Shade and Bulb Over the Telephone, This Instrument Becomes Considerably Dressed Up. The Mouthpiece Is Concealed by a Bunch of Flowers Thru Which Conversation Is Carried On.

This New Electric Mixer, Which Clamps to the Kitchen Table, Mixes Your Drinks in a Thoroly Sanitary Way by Revolving the Glass Container. No Mixing Rod Is Exposed to Dirt and Flies as in the Old Style Mixer. The Glass Container Comes Apart in the Center for Filling and Washing Purposes.

When One Becomes Weary of Certain Phonograph Records or When They Are Cracked, They May Be Made Very Useful "Citizens" by Becoming Stands for the Electric Iron. There Is Enough Wax in Them to Keep the Iron Smooth.

Above: The Electric Iron Now Has a "Companion" in a New Base Which Holds the Curling Iron, so That the Heat from the Iron May Be Used for Curling Purposes.

At Left: Have Your Photographer Make a Positive of Any Negative, on Glass. Frame the Positive, and Adjust an Electric Light Bulb in Back so That the Light Will Illuminate the Portrait. When the Positive Has Been Colored the Effect Is Specially Pleasing.

The New Electric Fireless Cooker Permits the Housewife to Put Her Food Cold into the Cooker, Adjust the Electricity by the Clock Attachment, and Then Go Away Knowing That Her Food Will Be Properly Cooked When She Returns.

Photos by Edna Purdy

"So Suddenly Did This All Happen That I Scarcely Realized What Was Going On, Until I Glanced Down at My Shirt Front. Imagine My Unutterable Horror When I Saw the Tell-Tale Patch of Red Light Cast on My Shirt Directly Over My Heart! For a Moment My Heart Actually Stood Still, Then the Blood Began Racing Madly in My Veins, Pounding in My Temples Till I Thought They Must Surely Burst."

The "Ultimate Ray"

By RAY WHITCOMB

TO Trevis Reynolds, I am indebted for the one big adventure in my otherwise drab and prosaic existence, for had he not casually mentioned Marvel Creek as an ideal trout stream, I might never have discovered the existence of Pax Marriote and would consequently have avoided an experience of uncanny and exquisitely terrifying nature.

I doubt not but that nine-tenths of you who read this narrative will sagely wag your heads and mentally observe that "they're not all dead yet." I realize that I cannot reasonably ask a skeptical world to give credence to a tale that sounds like a vision from the realms of delirium,—a figment of a shattered brain; but I do ask thinking people to remember that the long strides of modern science have made possible a score of inventions which other generations must have looked upon as supernatural, as utterly beyond human achievement.

Being chief electrician in a large commercial lithographing establishment I found little time for recreation during the long winter months, and accordingly looked forward with genuine pleasure to my two weeks vacation in the late Spring, when I could get away from the eternal stench of printer's ink and the racking din of the press-room. Victor Bryce, assistant bookkeeper, was to have his vacation at the same time, and as we both enjoyed fishing, it was decided to try out Marvel Creek.

Accordingly, a sultry morning in May found us casting in the cool, racing waters of a mountain stream, many miles from the turmoil of the city. I had excellent luck and by noon was ravenously hungry. After a hearty meal, I left Bryce to doze in the warm sunshine, and, slipping a hatchet in my belt, started out for a stroll up-stream.

I wandered along the bank, heedless of time, clambering over boulders, sitting down to rest occasionally, pelting stones at trees, tumbling rocks into the riotous waters, and behaving generally like some truant schoolboy; when suddenly I felt a chill. In surprise, I glanced at the sky. The sun, which had been shining brightly when I left, was just disappearing behind the dark thunder cloud, and others hung low and threatening over the surrounding hills. A deathly silence prevailed, the awesome and ominous calm of Nature which preludes a mighty outburst.

One glance was sufficient to cause me to start rapidly retracing my steps. Colder grew the air, and colder; while the increasing gloom rendered my progress more and more difficult. Once, I slipt, narrowly missing a bath in the cold waters, and now came a distant rumbling that rolled and echoed weirdly.

I decided that is was useless to attempt to reach camp before the storm, and as a big raindrop struck my neck, followed by another on my arm, and yet another, I turned and started into the woods in search of some temporary shelter. Lightning flickered faintly in the south and the darkness became so intense that I could scarcely see the trees about me.

The downpour increased and soon a dazzling flash of lightning streaked across the heavens, followed by a mighty clap of thunder. In the ensuing darkness, I struck my head against a low branch and sank to the ground, exhausted and half dazed by the blow. The rain came down in torrents and soon drenched me, while the lightning split the darkness intermittently and the thunder crackled in one incessant tattoo.

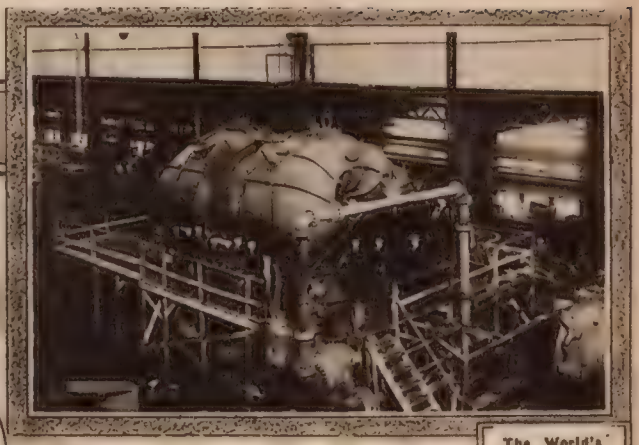
During a particularly brilliant flash, I caught a fleeting glance of something that looked like a wall not far off, and raising myself to my knees, I waited. Then came a momentary blaze of light, and, with a little cry of relief, I staggered to my feet and went stumbling blindly forward. In one short instant, I had seen that I was at the edge of a clearing—that scarcely a hundred feet away stood a house.

Guided by another flash, I reached the building, found the door, and not waiting to knock, sprawled onto the floor, kicking the door shut behind me. There I lay,

(*Continued on page* 442)

Science News in Photos

Dr. Nainget, a Student in the Study of the Human Diafram Has Just Completed Some Interesting Experiments on the Prognosis of Each Case Presented, Classifying People Morally and Physically. This Photograph Taken During an Experiment Shows How the Patient Is Placed Behind the Screen of an X-Ray Machine, Revealing the Outline of the Diafram.



The World's Largest Steam-Electric Generator, Capable of Delivering 60,000 Kilowatts or 80,000 H.P.

It Is an Easy Matter to Find a Way With the Least Obstacles for the Baby "Buggy" on a Dark Street by Putting on an Electric Light as Shown in the Illustration. Photo by Lisa L. Chase.

"The Sirena," a Motor Car-Boat Now on Exhibition at Atlantic City, N. J., Is a Fully Equipped Motor Car, Capable of Making 60 Miles an Hour on Land, and When the Driver Wishes, It Can Be Driven Into Any Stream at a Speed of 20 Knots.

Miss Beatrice Irwin of New York, an Exponent of the Higher Culture in Electric Lighting, Who Is Doing a Great and Interesting Work in Developing Harmonious Color Schemes for the Lighting of Residences. Miss Irwin Demonstrates the Various Effects of Well Planned Colors

Max Rindskoff, Inventor, on the New York City Police Boat "Hylan," Demonstrating How His Life-Line Hurling Gun Works. The Gun Shoots a Life Line Accurately 1,400 Feet and Has the Highest Commendation of the U. S. Steamboat Inspection Board.

Beneath the Giant Airship R-34, Which Is at Present Stationed at Howden, Yorkshire, England, an Airplane Is Hung To Be Used for Short Maneuvers While the Giant Airship Is in the Air. There Are Trapdoors in the Bottom of the Airship Thru Which a Pilot Can Drop Directly Into the Airplane

The "Master Key"

By CHARLES S. WOLFE

I FOLLOWED Fenner thru the door of Davidson's office. We found the worthy Chief of Police seated behind his desk, from which vantage point he greeted us with an unusually cheerful "good morning."

He seemed in rare good humor, and I noted the quizzical uplifting of Fenner's eyebrows as he advanced to the desk and leaned lazily against it.

"We received your message, Chief," drawled Fenner, "and we came right down. What have we now—murder, mayhem, larceny or abduction?"

Davidson rose. "Come on into the office and let him tell you the story himself," he said over his shoulder, as he led the way, and with aroused curiosity we trailed after him.

Seated at the table was a well drest young man whose face bore no trace of the mirth that seemed to have gotten the best of Davidson. As we entered he glanced up quickly, and I imagined I saw the shadow

He spoke in low, cultured tones, not looking directly at us, and toying with a paper knife in a nervous fashion as he talked.

"I find myself in a most embarrassing situation, Mr. Fenner," he said, "and Davidson tells me that he is unable to give me any assistance, because the matter cannot be considered as legitimately in his line. I suppose he's right, and also I admit that I am showing poor sportsmanship in asking aid in this business, but you will understand that it is not the money involved that leads me to unfair play. I am in a fair way to become the laughing stock of the city,

See What Kind of a Detective You Are! This Man Was Locked in a Room With Bolts on Both Sides of the Door and Yet He Got Out—and All the Bolts Were Still Locked. Also, He Didn't Go Out Thru the Window! How Did He Get Out, Then? That's the Mystery.

Davidson laughed outright. Involuntarily I started. It was the first time that I had heard a laugh out of the usually taciturn chief. In fact, I firmly believed that the very farthest he would ever get in that direction would be a broad grin. And I realized that something unusually humorous must have come up to betray the police head into open mirth.

"None of the bunch you so glibly named, Joe," chuckled Davidson; "in fact, we have nothing. Everything is going nicely. I don't need you at all. But I've got a bird in my private office there who needs you badly. I'll say he does. Oh, boy! Wait 'till you hear his story!"

"Sounds interesting," admitted Fenner. "What is it? Usually obedient daughter eloped with the family chauffeur—something of that sort?"

of disappointment cross his features as Davidson introduced Fenner.

"Meet Mr. Fenner and his friend," said Davidson. "Joe, this is Mr. Watson, son of John Watson, who has the ice plant. Fenner here, Mr. Watson, is the man I think you want. Tell him your story. You'll excuse me, for I'm rather busy this morning."

Davidson left us, and as we seated ourselves across the table from Watson, I began studying him covertly. For he was a well-known figure around our town. Son of one of the wealthiest of our citizens, he was prominent in all the big social activities of the "upper set," and a member of all the exclusive clubs. His name was constantly appearing in the public prints, and I made the most of this opportunity to get a line on the man.

and at all costs this must be prevented."

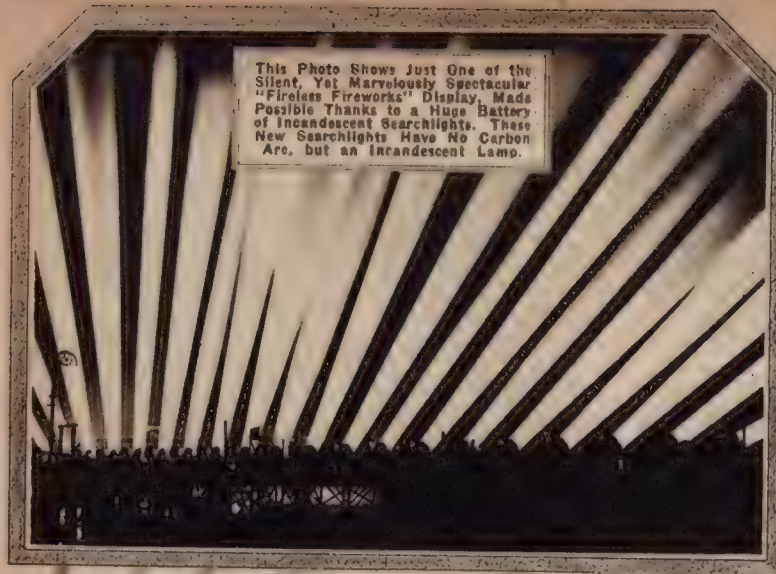
"And what is the difficulty, Mr. Watson?" Fenner asked, politely, as the clubman paused.

"It is a silly bet that I was foolish enough to make at the Lynx Club with young Fair yesterday afternoon. We were discussing some of the popular books of the day, and finally worked around to a detective story which is having quite a run. Maybe you've read the thing—chap is murdered in a room to which there is no apparent ingress possible without detection—that sort of stuff. I remarked that all this kind of business was drivel—that in everyday life such things could not, and did not, take place. Young Fair, with all the romanticism of youth, defended the writer and his clan. Said that things occurred in reality that outdone the

(*Continued on page* 431)

ODD PHOTO CONTEST

(SEE STORY ON PAGE 378)



This Photo Shows Just One of the Silent, Yet Marvelously Spectacular "Fireless Fireworks" Display, Made Possible Thanks to a Huge Battery of Incandescent Searchlights. These New Searchlights Have No Carbon Arc, but an Incandescent Lamp.

"Plumes" Produced by "Fireless Fireworks" Display, Combining the Agencies of Steam Jets, Supplied from a Small Boiler and the Brilliancy of Many Incandescent Searchlight Beams Thrown on Them.

This Searchlight Incandescent Lamp Is Capable of Producing 10,000,000 Candle-power in the Beam. It Is Shown Here Compared to the Ordinary 25-Watt House Lamp.

This Photo Shows a Particularly Interesting Effect Produced by the Combination of Escaping Steam and the Powerful Flashes of Light from a Battery of Incandescent Searchlights of the Latest Type.

Another View Showing the Wondrous Brilliancy and Novel Effect Which Can Be Produced Against the Sky at Night, When a Battery of the New High-power Incandescent Searchlights Are Properly Arranged and Focused.

"Pin-wheel" Effect, Produced by Flashing the Beams from a Bank of Incandescent Searchlights on Figures Formed by Escaping Steam.

The Picture Herewith Shows How "Feathers" Can Be Formed by Steam and Then Illuminated in Any Color Desired, or by Ever-changing Colors.

"Fireless Fireworks"

By E. W. DAVIDSON

Of the General Electric Company

IMAGINE attaching a searchlight to the lighting circuit in your house some night and throwing a beam of light so powerful that a man standing a mile away in this beam would have light enough to read a newspaper! It can be done. This is not to say it will be done often, however, for various protective devices would be necessary. But the incandescent searchlight, which can operate on either an alternating or direct current circuit with proper auxiliary devices, has establisht itself, replacing arcs of medium size for many purposes.

The first use of the new type of searchlight for spectacular effect was made at Saratoga Springs on the night of June 19 when that city turned on its new street lighting system in the midst of an illumination carnival. The powerful beams of 18 searchlights, playing thru the heavens that night, were cast by *incandescent lamps*—a fact unknown to most of the thousands who witnest the celebration.

These 18 beams wrought skilfully produced columns and curtains of steam into great, soft-tinted phosphorescent fans and plumes. They streaked the black sky with beauty, tracing bombs up into the night and dyeing little clouds of powder smoke with variegated tints. They turned the glare of ordinary fireworks into a radiant effulgence such as few Saratogans had ever seen. Their brilliant light helped make memorable the Saratoga festival of light.

But their use is by no means limited to gay, spectacular illumination. The incandescent is fast replacing the arc in searchlights of the type used by river steamers and coastwise vessels. Where a tower or high building facade is to be flood-lighted, the incandescent searchlight supplies accurately directed beams for the high points which are too dimly lighted by ordinary flood lamps. Where construction is proceeding at night and distances or heights are beyond the reach of smaller reflectors, these searchlights, ranging from a few hundred thousand up to ten or eleven million candlepower are playing their parts.

The new type of searchlight is the natural outgrowth of the lamp which succeeded, in the parlor stereopticon, the sputtering arc which rendered such doubtful service in the hands of amateurs. The stereopticon incandescent was such a markt improvement in steadiness, simplicity and economy over the arc that is was developt into proper sizes for small and medium moving picture projectors. The next step into the searchlight field was logical.

W. D'Arcy Ryan and his corps of experts in the General Electric Company's Illuminating Engineering Laboratory who made the searchlight of both arc and incandescent types what it is today, labored long before they found the best method of shaping and mounting filaments so as to secure concentration of the light source in the incandescent lamp sufficient to produce a strong beam. Tungsten wire of various diameters wound into helical loops were tried in long coils and short—and even in a conical shape—but exhaustive tests showed that three types were superior to all others.

In a 115-volt, 1000- or 1500-watt lamp capable of producing from one to two million candle-power in the beam, six perpendicular coils of filaments are mounted in the form of the letter C, the convex side of this arrangement presented to the mirror.

The other two secure greater concentration for longer throws by operating at far lower voltages with correspondingly higher currents. A 32-volt, 1000-watt lamp, good for about four million candle-power, has four perpendicular coils mounted at the corners of a closed square. The third and most powerful of all is a 12-volt lamp of 100 amperes capable of developing as high as twelve million candle-power in a beam of 3 degrees. It has a grid of five coils mounted in a single plane. Of course, to operate these lamps on land, transformers or resistances are required, depending upon whether the circuit is alternating current or direct current. The 32-volt lamp will operate with no appurtenances on the average boat circuit, which is usually of 32-volts pressure. The globes for all these lamps are of hard glass, lead glass being too soft to withstand the tremendous heat generated.

Beginning this year, sane Fourths of July have taken on new glory with the brilliant aid of these incandescent searchlights. Spectacular color effects and beautiful ground and aerial displays have been worked out by Mr. Ryan for scores of great outdoor night pyrotechnics such as those at the Panama-Pacific Exposition, the Hudson-Fulton celebration and other illuminations nationally famous. Many of these have adaptations which could be used and doubtless will be used in "fireless fireworks" shows of the future based on incandescent searchlights which cost less, operate more economically and are far more adaptable to varying conditions than arc searchlights of medium size.

The Chances For Experimental Chemists

THE war-time closing of the wireless stations, the most popular and best developed field for the experimenter, made it necessary for thousands of scientifically inclined young Americans to find some other field of activity upon which to expend their surplus time and energy. The writer wishes to suggest a line of work in a field which would not be thus affected and one which offers a splendid opportunity for patriotic service, namely: the field of Chemistry.

Due to German supremacy in the chemical industry, this country was, before the war, dependent upon Germany for a large proportion of the chemical products needed in its industries, and when the German markets were closed to us, many of these industries were seriously affected. We must secure chemical independence from Germany as well as make the world "safe for democracy." The war of arms, in which we strove to destroy Germany's military supremacy, brought about a war of brains in which we must combat her chemical supremacy. Every experimenter in the country should get a working knowledge of the principles of general chemistry, and if possible, of analytical and industrial chemistry, as well, in order that he may be prepared to play his part in the struggle to free the United States from its dependence upon any foreign country for chemical products.

The writer therefore suggests that a national society be formed to promote the study of chemistry, and that SCIENCE & INVENTION sponsor the movement and act as the official publication of the society. SCIENCE & INVENTION is the best fitted magazine in this country for such a task. Its work in organizing the amateur wireless operators of the country, and in building up the greatest amateur wireless association in the world, is well known, and it has a splendid reputation for supplying the latest and most authoritative wireless and electrical news to its readers. It is already publishing a large number of chemical articles, and it would be but a step from this work to the organization of a national society for young chemists, a sort of Junior American Chemical Society.

The object of the society would be to encourage the study of chemistry, to bring all the chemical experimenters into one great organization, to enable local societies to be formed of experimenters who live in the same locality, and to build up a market for chemical supplies for amateurs, so that the supply houses will be justified in carrying large stocks of supplies, and in selling them cheaply. This last point is very important. When the wireless game was new, and there were but a few wireless experimenters, the demand for amateur wireless materials and instruments was so small that supply houses carried very incomplete lines, and were forced to charge almost prohibitive prices to make any profit at all. As more and more experimenters became interested in wireless, and as they became better organized, the demand for instruments and materials became so great that the supply houses were able to carry a much more varied line, and sell it cheaper. This movement went on until a great variety of equipment was available at very reasonable prices, and the study of wireless was within the reach of almost everyone.

The same thing will be true of the study of chemistry. If a large number of experimenters take up the study, organize, make known their wants, the supply houses will begin to carry large lines of chemical equipment and reagents at low prices, and this in turn will encourage more experimenters to take up the work, until a great organization will be built up which will be of immense service to the country in developing chemists to meet the ever-growing need.

JOHN C. HENDERSON
(Member American Chemical Society).
Akron, O.

[*An excellent suggestion. We would like to hear from our chemical enthusiasts what they think of the idea. Write us one and all!—Editor.*]

EXPERIMENTAL CHEMISTS!

The young chemist of to-day will be the consulting and analytical chemist of to-morrow. The reasons why the field of chemistry is bound to grow and why it should be adopted as one of America's greatest and most important technical and commercial institutions, is interestingly explained by Mr. Henderson in the accompanying article. We believe in the future of the American chemist. He is ordained to accomplish great things in the days that are to come. Let him make a good start now.

ODD PHOTO CONTEST

See Page 375 of Rotogravure Section for Photos.

$1.00 Paid for Each ODD PHOTO Accepted and Publisht

1. A REAL "DYNAMIC" PICTURE.

What do we see here?—*dynamos growing in gardens?* Well, "things aren't always what they *seem* to be," and this is no exception to that rule. This freakish photo was produced by a double exposure, showing in the foreground a man and woman seated on a bench among abundant foliage, and in the background a powerful dynamo, so large that the man in front of it is only about three-quarters of its height.

Contributed by HORACE ROURKE.

2. SOME HIGH FREQUENCY SPARK!??

This illustrates a *seemingly* realistic high frequency phenomenon, which is simply a delusion produced by the utilization of a common "Daylo" flashlight, which was used for the purpose of focusing properly; and the movement of the flashlight to and about the group pictured, was recorded on the film after the shutter had been opened.

Contributed by HARRY L. BURNAH.

3. AN UNUSUAL NIGHT PHOTO.

This is a picture of the illuminations of the "Parliament Buildings and Post Office" of Victoria, Canada, taken at night, by means of a twenty-five minute time exposure.

Contributed by G. V. MALLOWS.

4. A SKYROCKET IN MOTION.

This picture at first glance would apparently appear to be one of a skyrocket, taken while in flight, but in reality is an actual photograph of the path taken by the moon, sometime in July, 1919. Very few photos of this nature have ever given satisfactory results, and it is not very often that the moon can be photographed in this manner, and still have the picture show its *actual* path as clearly as this.

Contributed by EDGAR R. MALLORY.

5. UNUSUAL "LIGHTNING" PHOTO

This print was made from one of several plates exposed during a thunderstorm at night, some time ago. I stood upon the topmost step of the porch, and faced directly across the street. Down the street to the left (about 125 yards) was a street lamp of the arc type. Before opening the shutter and drawing the slide, I faced the shadows of the porch rather than risk a flash coming when I was in the middle of the operation. Then with the camera all set, I swung around and pointed it at the storm. A flash came, and I turned the camera away to the shadows, but upon second consideration, decided that the flash was not brilliant enough, and would expose the same plate again, which I did, and caught a very vivid flash.

Upon developing the plate, I was astonished at the result and have since figured it out this way: The two flashes are of course understandable, and I figure that the other lines were caused by the arc lamp in the distance, as I swung the camera from darkness under the porch, to the sky. Where the solid line changes to dotted ones, the effect is caused, according to my theory, by the speed of the moving lens separating the alternating current feeding the arc.

Contributed by LANDON W. L. EDMONDS.

6. RE-INCARNATION?!!

Do you believe in re-incarnation? If not, perhaps another look at the accompanying photograph may change your opinion. The individual pictured, evidently has faith in the motto, "If at first you don't succeed, try, try again!" and is making an easy matter of studying "Skull"-ography—enjoying a "weed" at the same time.

Contributed by GERARD ZANKE.

7. X-RAY OF DOLLAR WATCH.

Herewith is shown an X-ray picture taken of a dollar watch taken thru the 1/16" thick brass plate enveloping the works, which latter are very clearly shown. A chain and glasses were also attached to the watch, but these are minor features in this extraordinary photograph. X-ray pictures such as this, especially when taken under ordinary conditions, very seldom if ever give the splendid results obtained in this photo.

Contributed by HENRY VOGEL.

8. SOME GHOSTLY HANDS, EH! WHAT?

Altho at first one would presume this to be a picture of a pair of *ghostly* hands, it is none other than a photograph of a lightning arrester used on distribution line tests for the purpose of determining the wet flash-over voltage, to approximate the operating conditions. This arrester was tested on 60 cycles, the capacity of the testing outfit being 50 kilowatts. The voltage applied in this case was 48,000, the insulator being very wet. The flash pictured caused no damage to the arrester. The air gap was set for 13,000 volts distance.

Contributed by W. G. McKENZIE.

9. A "TANK" IN ACTION?

This is a photograph of a miniature tank in action, and is so very realistic in appearance that it is indeed difficult to believe that the startling, weird effects were produced thru trick photography. The unusual lighting effects were obtained by placing a small amount of flashlight powder directly in front of the camera, and the results were far above any expectations.

Contributed by GEORGE ALEXANDERSON.

10. HE SEES HIMSELF FIVE TIMES!

This photograph is one of a man seated at *apparently* five different places around the table. It was taken by one exposure of the film. Two large mirrors were placed at right angles on top of the table, and the person sat directly in front of them, with his back to the camera. Thus the only authentic picture is the one where he is seated backward the other remaining views being only reflections. The room in which this photograph was taken was a poorly lighted one, thereby making it necessary to employ artificial means of illumination—hence a 500-watt nitrogen bulb was placed just over the camera, producing the desired results.

Contributed by CARLETON SUTLIFF.

11. AND WHAT IS THIS?

The weird looking picture shown herewith is one of "The Gyroplanes" in motion at Luna Park, New York, taken by means of a time exposure. This is *indeed* an odd photo! And the effects produced are not alone beautiful in appearance, but are seldomly obtained in such a striking aspect. Who could guess on first inspection, that this queer photograph was one taken of the revolving Gyroplanes?

Contributed by K. STRICKFADEN.

12. REMARKABLE ICE-COVERED WIRES.

This is a photograph of some remarkable ice-covered wires, taken during some very unusual weather conditions, in Petaluma, Calif., last January. It was raining heavily at the time this picture was taken, and the temperature was about 32 degrees Fahrenheit, thus causing the falling rain to freeze on the wires—the ice on some parts of the wire being over two inches thick!

Contributed by FRED W. TUCK.

French Airmen Predict Ten-Hour Transatlantic Flight

To fly from France to New York in ten hours is the latest and most ambitious dream of French airmen and inventors. They declare that it will be done within the next few years by means of two new inventions, which enable an airman to fly at a height of 40,000 feet, where, owing to the reduced air pressure, a speed of 450 kilometers (282.6 miles) an hour can be maintained.

Two difficulties which face the inventors are, first, to secure the functioning of the engine and driving force of the propeller in that rarefied atmosphere, and, second, to secure a life-supporting atmosphere for the airman and passengers.

The first of these difficulties has been largely overcome by an invention which was recently used by Lieutenant Henri Roget, who flew from Paris to Lyons, a distance of nearly 285 miles, at a speed of 156 miles an hour. Roget flew at a height of 15,000 to 18,000 feet all the way and was able to maintain his speed in the rarefied atmosphere by means of an invention which comprest the air fed to the carbureter to normal atmosphere.

Since then a controlled trial has shown that a motor giving 178 horsepower at water level and ninety-five horse power at 1,500 feet can be made to give 166 horse power when the air is comprest by the new apparatus. To that extent the effect of rarefication of the air has been overcome, and it seems certain that, the principle having been established, further development will be rapid.

The second difficulty is to secure breathing air for the fliers. The example of the submarine is here invoked. There is no more difficulty, it is stated, in making an inclosed chamber provided with air at normal pressure which will travel above the clouds than in making one which travels below the water.

Once these two problems are effectively solved full advantage can be taken of the non-resistance of the upper air. To go quicker one will have only to go higher, and, incidentally, to go cheaper, for on the faster voyage less fuel will be burned. In those days we will have a nightly service of airplanes following the dawn across the Atlantic and dropping down in New York in time for breakfast.

In This Canadian Railway Telegraphy School the Students Derive the Utmost of Practical Learning, Not to Mention a Host of Pleasure from Operating This Complete Electrical Railroad System, Which Is Equipt with Interlocking Block Signals, Switches, Etc. This Miniature Railroad Is One of the Most Complete Ever Installed in Any Railway Telegraph School, and Is a Credit to the Instructors Who Have Built It.

School Has Miniature Railroad

"Learn how to do things, by doing them," is the policy of one of the large Canadian railway schools, and in order to carry out this effect to better advantage, this school has been equipt with a complete model of a trans-continental railroad system, including among other things sidings, yards, switches, stations with semaphores, train-order boards, switchboards and telegraphs connecting each station with an outside telegraph wire and one with the dispatcher's table and, of course, a complete telephone system.

An extremely unique feature is added, namely, that of controlling the trains entirely by radio-dynamics, or better known as wireless control. Each individual train can be started, reversed or stopt at the will of the dispatcher independently of any other train on the tracks. In this way the pupils obtain a complete course by the use of these six-foot models, which stop and start off again on their run.

The semaphores at each station enable another method of signalling; all of them are worked automatically, the same as in the large railroads.

For night dispatching, all trains, semaphores, signals, markers, and switches of any nature are equipt with electric lighting systems which assist the pupils in correctly dispatching the trains even when the room is enveloped in darkness.

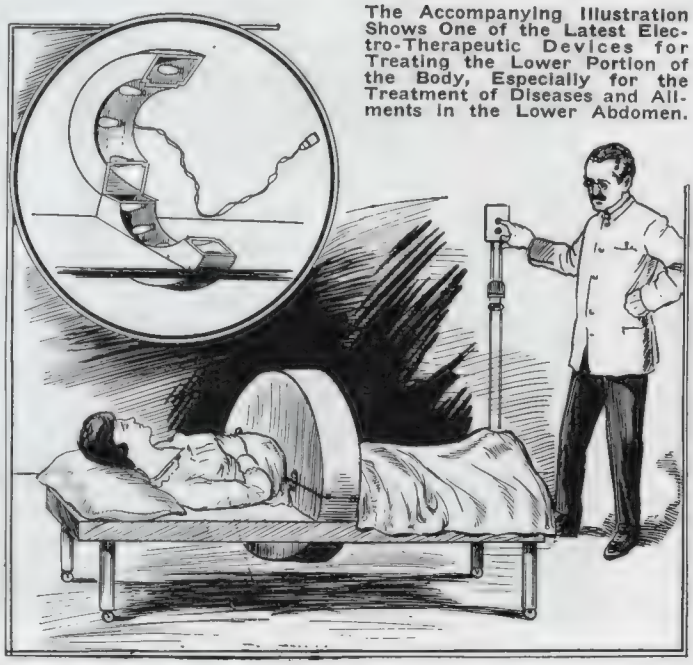
The phonetic system of memorizing is used and the school thoroly equipt with telegraph instruments, so that a complete course in telegraphy at the same time may be obtained. Many railroad officials who have visited the institute and inspected the equipment were amazed and pleased by the remarkably complete methods and the exact replica of the trans-continental systems.—

Photo courtesy Canadian Schools of Telegraphy and Railroading.

Electric Light Cures Diseases

ONE of the main objects of the invention here illustrated is to provide an apparatus of the character stated by means of which the lower portion of the body may be subjected to the action of heat and light rays from all sides, so as to effectually penetrate the body and to kill the disease germs and reduce inflammation and promote circulation. A further object is to provide an apparatus which is specially adapted to fit about the lower portion of the body for treatment of diseases of the bladder and similar troubles. Further objects will appear from the following detailed description.

In practise, the patient is placed upon the cot, after which the upper section of the casing is lowered so that the sections completely inclose the lower portion of the patient's body, as shown in the diagram. The two sections fit snugly together at their adjacent ends, so as to form tight closures, and a suitable cloth or pad may be placed about the patient's body and the edges of each of the end plates of the respective sections; this cloth serving to prevent escape of heat from the casing. After the patient has been properly placed upon the cot and the casing has been closed as described, the lamps are illuminated so as to generate light and heat. The light and heat rays are directed by the reflecting inner surfaces of the sections of the casing onto the patient's body and penetrate the same, the dry heat thus produced and the light rays coacting to kill the disease germs and reduce inflammation, while promoting circulation and the growth of the friendly germs, thus effecting a cure. "I have found this apparatus, due to its adaptability to concentrate the heat and light rays upon the body so as to cause penetration of these rays into the body, very efficient in the treatment of diseases and affections of the lower cavity of the body"—says the inventor of this newest electrotherapeutic treatment apparatus, Mr. Vern Linn Ruiter, of Roseburg, Ore.



The Accompanying Illustration Shows One of the Latest Electro-Therapeutic Devices for Treating the Lower Portion of the Body, Especially for the Treatment of Diseases and Ailments in the Lower Abdomen.

Electric Lights for Cows, By Cows!

The recent tie-up of the railroads and the increasing traffic on the highways have caused considerable uneasiness on the part of the leading members of the Cedar Grove, New Jersey, Board of Poultry Trade, says "Farmer Smith" in the *New York World*. Artist Ellison Hoover, of Newark, advocated the abolition of State roads in New Jersey on the ground that they are a burden and expense to the poor taxpayers.

"BULLS" SHOULD BE MARKED AT NIGHT BY RED ELECTRIC LAMPS THUSLY.
GREEN LIGHT
SPRING RATCHET PULLEY
DYNAMO
WHITE LIGHT
STORAGE BATTERY
DYNAMO DRIVING CORD FASTENED TO LEG
RED "TAIL" LIGHT
MOEY! BOEY! (MEANING: MOVE OFF THE ROAD)

"Tie That Little Bull Outside" Would Seem to Apply to the Accompanying Electric Bull Story, but When You Come to Think About It, It Isn't as Crazy as It Looks. A New Jersey Farmer Has Suggested Placing a Small Dynamo Similar to the German Trench-Light Generator on the Back of the Animal and as It Walks the Dynamo Will Supply Current for the Lights and Perhaps a Storage Battery—Even Down to a "Tail" Light.

The whole trouble has come about thru the passage of the bill at Trenton which fines the owners of bulls (live) when said animals are found upon the highways without chaperons.

Further, automobilists are complaining about horses and cows roaming on the roads after dark without lanterns for tail lights. As autos have to have lights why not animals, it is argued.

The board was pleased to receive the report of Wallie Dobbs, Chairman of the Highways Committee. Wallie states that he has received from F. Bergamo, inventor of the Superheated Hen's Nest, the outline of an invention which Mr. Bergamo is perfecting in Newark. This provides for a dynamo to be attached to the backs of horses and cows which is operated by a shaft attached to a leg, much like the driving rod on a locomotive. This dynamo generates electricity, which is stored in batteries also strapt to the animals' backs and from which are run wires connecting with electric lights.

Thus it can be seen that white and green lights can be placed on the right and left of a horse's head, while a red light can be placed on the rear of the animal, so as to warn automobilists and others that there is an animal on the highway.

It was suggested by Hogo Peebles that in the case of bulls twenty-five red lights, twinkling like movie signs, be placed at convenient intervals on the beasts' backs.

A motion to have the battery feed electric fans to shoo off the flies was voted down.

Giving Batteries the "Third Degree"

By S. R. WINTERS

The wag who satirized life as being one d—— thing after another, may have gotten his "tip" from the life tests of storage batteries, which consist of a continuous series of charges and discharges, completing two cycles every twenty-four hours. Anyway, the United States Bureau of Standards has devised an automatic apparatus for such testing of dry cells and storage batteries, aiming to displace the prevailing methods, which are claimed to be arbitrary in their applications.

The "telephone," "ignition," and "flashlight" tests are the three ways of examining dry cells and storage batteries at present, involving the discharge of the cells thru resistances for varying periods of time. The newly-developed method of the Bureau of Standards might be called the "clock" test, judging by the prominence of a timepiece which controls the selective relays. The apparatus is adaptable to any form of testing at intervals, requiring the closing of electrical circuits at a specified time. A continuous series of life tests can be made, two complete cycles every 24 hours, without the presence of an observer.

The apparatus is capable of controlling a considerable number of widely varying periodic tests at the same time. There is an absence of rapidly moving parts, and the accuracy with which the intervals of discharge are timed, is equal to the regulation of the clock. The pendulum timepiece contains an electrical contact, the circuit being closed once every minute, and supplies an electrical impulse to one of two selective relays which are contained in the glass case. As each impulse is received, the shaft at the left hand end is advanced by one-sixtieth of a revolution, making one complete revolution every hour. Each hour this shaft furnishes a similar impulse to the coils at the other end of the apparatus, which causes the shaft at the right hand end to rotate. There are 24 teeth in the wheel at this end of the shaft, making one revolution in 24 hours.

Here We See One of the Government Experts at the Bureau of Standards Laboratories Putting Dry and Other Form of Battery Cells Thru Extensive Tests. The Batteries Can Be Periodically Discharged at Regular Time Intervals by Means of an Automatic Circuit Closer Attached to the Clock at the Right.

Illuminated Traffic Cop

The first traffic cop in the world to be "lit up" has been discovered in Boston, Mass. Owing to the great congestion of traffic at certain street intersections in Boston, it has been found necessary to protect the traffic officers with some sort of conspicuous marking, and the electric lights placed on the peak of the campaign hat and also on the shoulders were decided upon. The light on the hat is red, those on the shoulders are white. To make the officers still further discernible they wear broad white straps criss-cross across the breast and long white gloves on their hands. The "juice" for the lights is in two batteries carried in the pockets of the overcoat.

The photo shows Sergeant R. E. Blackeley, of Company D, Motor Transport Corps, Boston State Guard, our first illuminated traffic cop.

Boston, Mass., Has the Credit of Being the "Brain Center" of the United States, So We are Not Surprised to See the Latest Idea in Illuminated Traffic Cops Hatching Forth from That City. This Should Prove a Great Boon to Traffic Not Only On Stormy Nights, But On Street Crossings Which are Not "Over-illuminated."

This idea would seem to be a popular one. Possibly a little later they will rig up the red light to flash for "stop" and the white or green light to flash for "proceed." The blinking on and off the lamps being controlled by a push button conveniently located. Another good idea in this direction is the illuminated glove. Several patents have been taken out on these. Battery lamps serve the purpose very nicely.

Drink With "Legal" Kick

Here is a perfectly legal way of putting a *kick* in the drink. Two wires are connected to a medical coil. The other end of one wire is connected to some tin foil wrapt around the glass. Z-z-z-z. John Barleycorn never could produce so strong yet so safe a kick.

Photo from Edna Purdy

Chicago Shows Us the Way to Get a Drink with a Real "Kick" In It. Hook a Charged Wire to the Metal Cup.

NEW DRY FIRE EXTINGUISHER.

This latest invention comes from Germany where it is widely advertised and seems to have considerable merit. In German it is called *Total Automatischer Schnell-Kohlensäure Feuerlöscher,* meaning total-automatic Quick-Acting Carbonic Acid Fire Extinguisher! As the name says, the apparatus is worked by means of carbonic acid gas, which as is well-known, readily extinguishes flames. As our illustration depicts, all that is necessary to do is to turn the extinguisher in the direction of the flames, twirl a knob when the gas which is immediately generated by the extinguisher is made to pour over the flames, thus extinguishing them. How well the device works we have not been informed, but it seems to meet with considerable favor at the present time in Germany.

This Ferocious Looking Fire Extinguisher Is the Latest Thing in Such Devices Developed in Germany. It Has a Long, High Sounding Name Which Means a Total-Automatic, Quick-Acting, Carbonic Acid Fire Extinguisher. It Works By Means of Carbonic Acid Gas Which Is An Excellent Fire Extinguisher.

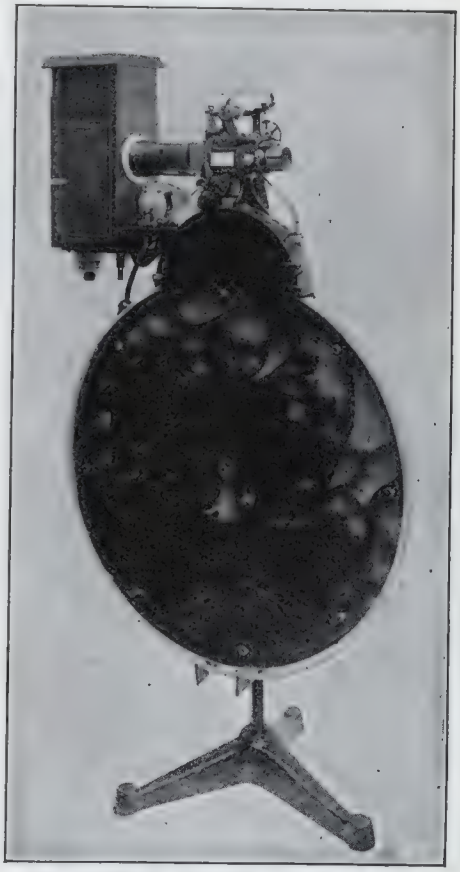
NEW ADVERTISING "MOVIE" MACHINE.

Here is a new machine which takes the motion picture and makes it a universal medium for advertising, publicity and education. It is claimed to be simple, practical and inexpensive. It makes good the wish of business men, educators, bankers, propagandists—all who want a message carried to the largest number in the most forceful manner at the smallest cost.

This clever advertising machine projects a motion picture any reasonable size. It does not require the services of an operator. It uses standard film and is automatic. It projects a picture over and over—a dozen times to a thousand times. There is no stopping to rewind or rethread the film and no danger from fire. The film can be stopt at any point and a picture held as long as desired. Also it can be used in daylight as well as in darkness.

The device is suitable for use in store windows, in class rooms, in waiting rooms, in hotel lobbies, in lodge rooms, in offices, in exhibition rooms, in homes, on steamboats, on railway trains, as a billboard attraction—any place where there is ordinary electricity.

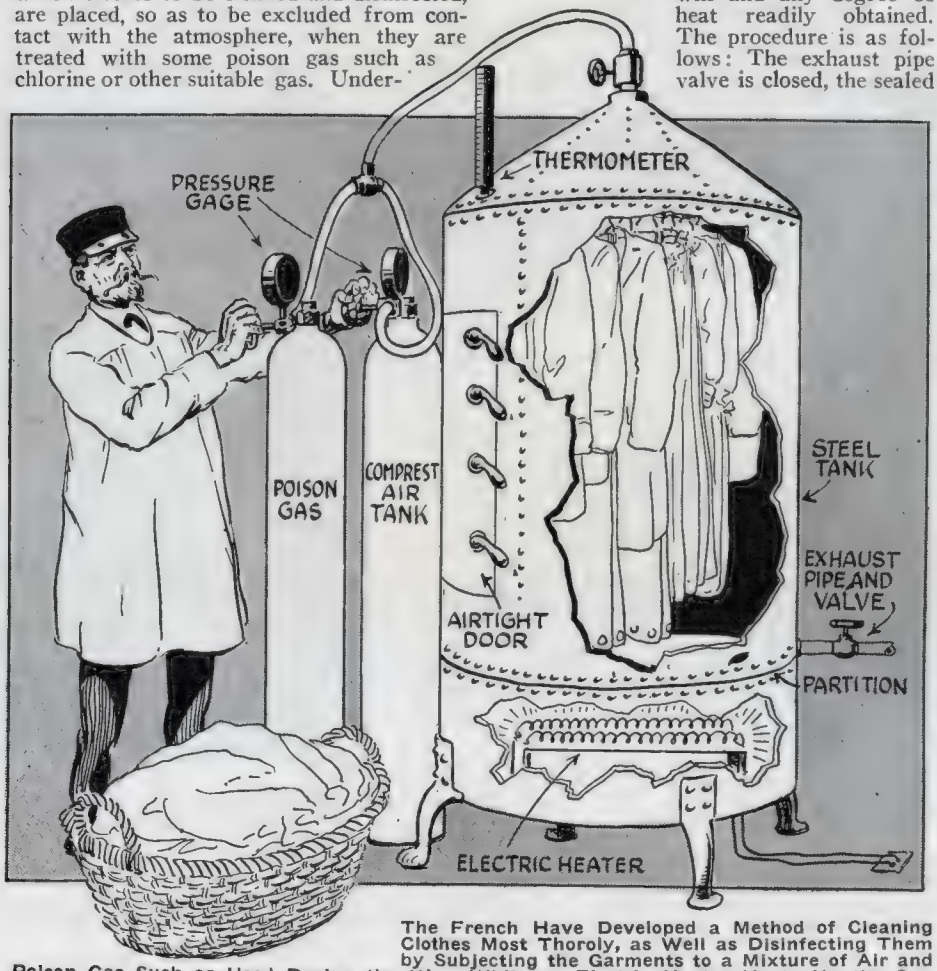
This automatic projector is the invention of John P. Burnett, of Chicago. Mr. Burnett is an experienced mechanician and inventor. Along with many others he heard the cry for a simple, automatic, motion picture projection machine—a machine that would give perfect continuous projection, anywhere, any time.



The Latest in Electric Automatic Movie Projectors.

Poison Gas Cleanses Clothes

In the accompanying illustration is shown one of the latest inventions in France, in the form of a steel treatment chamber, in which clothes to be cleaned and disinfected, are placed, so as to be excluded from contact with the atmosphere, when they are treated with some poison gas such as chlorine or other suitable gas. Underneath the steel disinfecting chamber, there is placed an electric heater, the strength of the current of which can be controlled at will and any degree of heat readily obtained. The procedure is as follows: The exhaust pipe valve is closed, the sealed air-tight door opened and the clothes hung within the round steel chamber. As many clothes as desired can be placed in the chamber as the gas will easily pass right thru them, and permeate every portion of them. The steel outer door is then closed by means of the levers shown, and the operator (the operative here shown is a typical French workman drest in a hat, trousers and blue denim gown, similar to that worn by the American laboratory workers, but only of three-quarter length) then opens up the valves and watches the gages on top of the tanks, regulating the mixture of poison gas and air to the proper amount.



The French Have Developed a Method of Cleaning Clothes Most Thoroly, as Well as Disinfecting Them by Subjecting the Garments to a Mixture of Air and Poison Gas Such as Used During the War, While an Electric Heater Heats Up the Gas Within the Chamber to any Degree Desired. The Operation Takes but a Short Time.

The temperature is carefully watched in all of the operations so that the clothes will not be scorched or burned and the gaseous atmosphere within the compartment is raised to as high a temperature as possible, as the heat tends to expand the gas and causes it to penetrate thru the clothes more evenly.

After the clothes have been treated several minutes, the exhaust valve in the pipe line which leads outside the building into a neutralizing tank, is opened, and the residual gas blown out of the treatment chamber by having the poison gas valve closed tight and opening the compressed air valve from a storage reservoir for a fraction of a minute. The door to the gas chamber is then opened and the clothes removed.

One of these poison gas disinfecting outfits will be installed in almost every hospital where all kinds of diseases are constantly being met with; the problem of killing these disease germs in clothes having heretofore been considered impracticable and the clothes therefore burned.

It would seem that this system solves the problem, and besides it is the most sensible idea for cleaning and disinfecting our everyday clothes at periodic intervals, as disease germs often lodge in the most unsuspected places.

Luminous Eyes for Nursery Zoo

In the two accompanying illustrations, our artist has portrayed two scenes, showing the "before and after" effects on the children who are unexpectingly greeted by the members of the nursery zoo after they have retired. Possibly, they had not noticed the effect of the luminous, radiumized eyes of Fido, Old Bruin and Jumbo—the Smaller.

But whether this was the case or whether Nursie thought to play a joke on them, the surprise is well shown in the illustration at the left, and so would you be surprised, even tho you are a grown-up—if, out of the inky blackness of your sleeping chamber, you suddenly awoke and beheld three shining pairs of eyes, staring forth with a strange greeny phosphorescence; for all of which surprises and novelty we have to give thanks to Miss Florence Garrigue, of Danvers, Mass., who has been recently awarded a U. S. letters patent on this toy.

But the aforegoing was not apparently the main idea entertained by Miss Garrigue when she invented this toy, for she says in her patent:

It is well known that many children have a natural aversion for darkness and will not go to sleep unless the parent or some other person remains in the room or within sight of the child, or unless a light is left in the room. In many instances, however, children are forcibly compelled to go to sleep in a dark room and as a result develop nervous diseases, which are retained thru a greater or less portion of their lives.

The present invention contemplates the production of a toy, such as a doll or other simulation of a living being—for example, a dog, cat, bear, etc., having *luminescent eyes* which toy may be taken to bed with the child and which the latter may be assured will watch over it during the night, thereby allaying the fears of darkness.

A further object of the invention is to provide a doll or other object of the character specified having a soft and pliable body which may be handled by the child in the night, as well as the day-time, without danger of injury to the child and which will be provided with eyes having a luminous appearance.

And What Are the Kiddies so Scared About? You Would Be Scared, Too, If You Happened to Wake Up of a Sudden and See Several Pair of Luminous Green Eyes Staring at You Out of the Darkness of Your Bed-room.

But Their Fears Are Quickly Turned to Joy When Nursie, in Response to Their Cries of Alarm, Winks on the Electric Lights and the Luminous Radium Eyes Are Discovered to Belong to Fido and His Friends.

The Electric Hairdresser

The "Hairometer," a Device That Gives the Hair a Turkish Bath at a Temperature of 300 Degrees, Being Demonstrated in London. The Heat Is Supplied by Electricity and It Is Said the Device Will Produce New Growth Rapidly.

At the Beauty Show Recently Held at the Palm Garden, Fifty-eighth Street and Third Avenue, New York City, a Permanent Wave Apparatus, Which at First Sight Seems to Remind One of a Highly Perfected Skull Crusher, Proved Its Worth as a Permanent Waver. The Machine Can Wave up Fifty-two Curls at One Time. This Photo Shows the Apparatus and How It is Attached.

"An Eye For An Eye"

The picture here reproduced illustrates one of the most remarkable optical freaks that we have come across in some time. It shows the clear reflection of the photographer who took the picture, in the dog's eye, said canine being one of the champion Airedales exhibited at the Dog Show, held during the last winter season in New York City.

It is seldom that one sees as clear a picture as this one, altho the phenomenon of the image reflected in the pupil of an eye, either human or animal, is fairly well known. Undoubtedly you have often looked in the eye of your pet dog and under the proper conditions were surprised to note the reduced yet perfect miniature image of your own countenance reflected in the animal's eye.

There has been for, many years, a theory that when a person is murdered, that the image of the murderer is recorded on the retina of the victim's eye, and that if the police authorities could photograph this image within a reasonable time after the death of the victim that it would render the task of discovering the actual murderer as simple as child's play.

Photo at Left Shows Image Photographed in an Airedale Terrier's Eye. The Original Image Was Much Clearer, of Course.

It must be said that there are many wonderful things about the eye, whether human or animal, that we do not yet understand, and the scientists of tomorrow will undoubtedly cause us to be really astonisht at the slight amount of knowledge we now possess of this most wonderful of all Nature's miraculous achievements.

Ex-Kaiser's Light Getting Rusty!

The latest cable from Europe brings t tidings that the Ex-Kaiser's erstwhile don cile in Berlin, the former home of the grea est militarist of all time, is rapidly dege erating so as to resemble anything but royal abode.

The present photograph shows how t birds have started to make their nests the electric lights on the exterior of t brilliant palace which formerly housed t Hohenzollern family.

The cable does not say very much as what is going on in Holland, where the e ruler of Germany daily saws a carload wood or so, but presumably the little birdi do not get much opportunity to build ne in the electric lights about his present abo

The Ex-Kaiser's Beacon Lights Are Getting Somewhat Rusty, and the Little Birdies Are Chirping Merrily as They Proceed to Build Their Nests in Them.

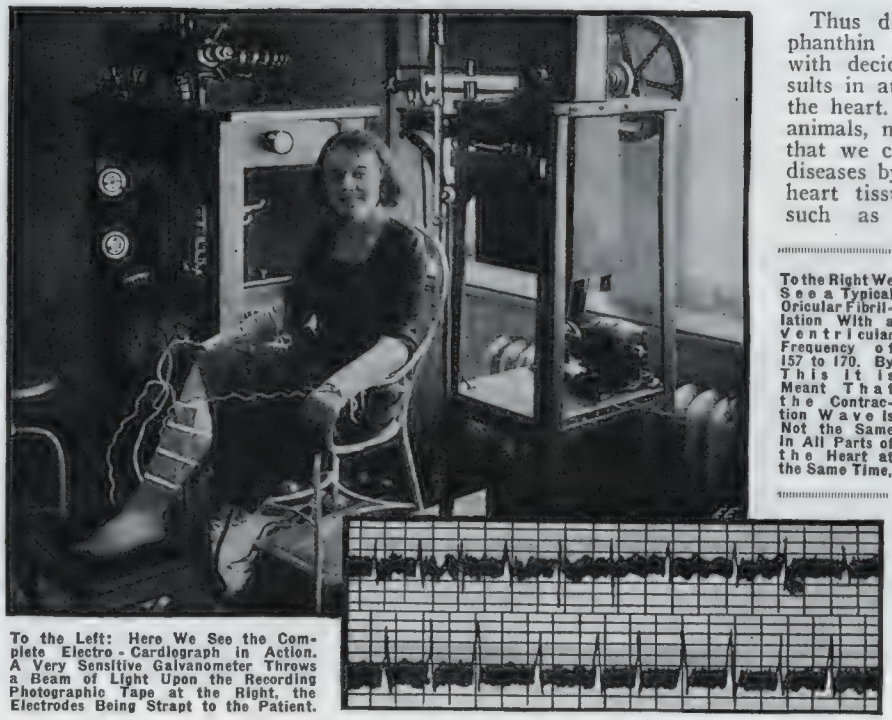
Electricity for the Treatment of Heart Diseases

THERE have recently been a number of controversies and newspaper reports as to the relative improvement which might result from the use of electricity, and also salts of calcium and potassium in large quantities, in the treatment of diseases of the heart, such as auricular fibrillation, auricular flutter and palpitation. Such reports are, however, discredited by the medical fraternity in general.

The most remarkable effects toward discovering what the heart is doing and what the causes of its improper functioning are, has been made possible by the use of the electro-cardiograph, an illustration of which appears on this page.

This device was described at length in the May, 1917, issue of this magazine, so we will dismiss it here with but a casual mention. There are three electrodes used, strapt onto both arms and the left leg of the patient. These are connected to the electro-cardiograph. The instrument itself is really a modified Einthoven galvanometer, consisting of a very powerful magnetic field excited by a direct current, and in the air-gap between the poles of this electro-magnet there is suspended a fine quartz filament. The image of this filament, when deflected by a current, is projected thru two small holes that extend thru each pole-piece.

These holes are the condensing microscopes and the projecting microscopes which serve to focus a fine beam of light upon a moving film actuated by means of an electric motor. Inasmuch as the heart contractions are of an electrical nature (viz., each contraction produces a current), by the simple employment of a Wheatstone bridge method the successive contractions of the heart are readily determined and photographically recorded upon a moving tape.



To the Left: Here We See the Complete Electro-Cardiograph in Action. A Very Sensitive Galvanometer Throws a Beam of Light Upon the Recording Photographic Tape at the Right, the Electrodes Being Strapt to the Patient.

To the Right We See a Typical Oricular Fibrillation With a Ventricular Frequency of 157 to 170. By This It Is Meant That the Contraction Wave Is Not the Same In All Parts of the Heart at the Same Time.

Recent reports contend that heart diseases can be cured electrically, but it is questionable whether or not electricity applied anywhere externally will have any material effect on either the rapidity of the heart beat or relieve the distressing organic disturbances of the diseased heart, inasmuch as when current is applied to the body it generally is dispersed before penetrating the tissues deeply enough. Therefore it would seem necessary to apply such stimulant to the surface of the heart directly or to its intrinsic nerves. And this, in most cases, is impossible.

It is a well-known fact that pressure on the vagus (a nerve which has a controlling action on the rhythm of contraction of the heart muscles) will cause this nerve to be stimulated sufficiently to slow down the beat considerably; likewise the effects of medicine upon diseased hearts exercise certain notable results.

Thus digitalis and strophanthin have been used with decided beneficial results in auricular flutter of the heart. In experimental animals, moreover, we find that we can produce heart diseases by forcing into the heart tissues certain salts, such as potassium, and again relieve this symptom by the addition of calcium; in the human being, however, it is found highly inadvisable to pump a large volume of a foreign substance into the heart.

As to the use of electricity (as an electric shock, for instance), in order to stop palpitation, we can say, and quite authentically,—that it has been found even in those cases executed in the death house by the electric chair, that the heart continues to beat, sometimes as long as five minutes after the person has been pronounced quite dead by the medical examiners. Not beating strongly, it is true, but one of those hardly perceptible heart beats, and therefore, it would seem that electricity regardless of how applied even to the *killing strength* will have practically no effect on the heart itself, except perhaps to slow the beat if taken in large amounts.

Dr. Robert H. Halsey of the medical department of the New York Post Graduate Hospital and Medical School has done an immense amount of *heart* work, and says: "If there were any truth in the report stating that electricity could be used for the control of palpitation and auricular fibrillation, we, who are engaged in this endeavor would surely be notified immediately."—*Photo courtesy Dr. Halsey.*

Melted Wood!

It is possible to melt wood by heating it in a vacuum, producing a hard, homogeneous substance. *Melted wood* was for a long time only a laboratory curiosity, but it may be that industry shall presently discover practical applications of the greatest interest.

Altho wood is eminently inflammable it melts at a relatively low temperature, but in very precise conditions, and only when it is absolutely removed from contact with oxygen so that its combustion is impossible. This may be understood when we remember what its composition is. When its immediately soluble constituents have been removed, by means of alcohol, for instance, it gives on analysis organic acids, water, oily essences, silicates, sulfates, phosphates, chlorides, and hydrocarbonates of lime, potash, soda and magnesia, carbonic acid, carbonated hydrogen, etc.—that is to say, solely bodies susceptible of being evaporated or dissolved after having cooperated by chemical affinity in the formation of determinate substances.

Starting from these data Messrs. Bizouard and Lenoir, in 1891, studied the problem of the fusion of wood. They operated in a closed vessel at a relatively low temperature—that is about all one can gather from the records of the period.

Their work was taken up by others, and now there is a full operative technic that enables us easily to obtain excellent results. A metal receiver, a sort of boiler having a double bottom thru which superheated steam passes, is filled with bits of wood. It is closed by a lid similar to that used in autoclaves and provided with a tube and stopcock communicating with an apparatus for exhausting the air. When the wood thus kept in a vacuum is heated above 284 degrees Fahrenheit the water and other volatile substances are given off first and are drawn off by means of the exhausting apparatus, after which the heating is continued for about three hours. There then take place a complex series of reactions and phenomena analogous to those that accompany the distillation of wood in a closed vessel, and in this way all the so-called pyrogenous products are separated; these in turn are drawn off, condensed and separated so that they may be utilized commercially. There then remain in the receptacle only the fibrous skeleton of the wood and the mineral salts, which taken together constitute a fusible mass. This is allowed to cool slowly, out of contact with the air, and then placed in a second boiler, which, after the air has been exhausted, is filled with nitrogen under a pressure of 1.5 to 2 atmospheres. The whole is heated to 1,500 degrees Fahrenheit, for two hours, and at the end of this time the wood is melted into a homogeneous, hard mass.

"SCIENCE and INVENTION"

What Prominent Men Think of Our New Name

FROM THOMAS A. EDISON.

The change of name from ELECTRICAL EXPERIMENTER to SCIENCE AND INVENTION better indicates the proper sphere of your journal. Your field is now unlimited and your journal will be of great value in the advancement of invention and industrial application of science.

THOMAS A. EDISON.

Orange, N. J.

FROM PROFESSOR RUSK.

Accept my congratulations on your new name and the increased field of your magazine. The change should win many new friendships and strengthen old ones. You are leaders in your field.

ROGERS D. RUSK, M.A.

McConnellsville, O.

FROM INSPECTOR KRUMM

In answer to your request as to my opinion of the new name SCIENCE AND INVENTION, I consider that it indicates more accurately the broad technical field covered by your always interesting magazine. My best wishes for your continued success.

L. R. KRUMM,
Chief Radio Inspector.

New York, N. Y.

FROM INSPECTOR CADMUS.

The new name is very appropriate. We think it the best magazine of its kind published.

R. Y. CADMUS,

Baltimore, Md. *Radio Inspector.*

FROM THE INVENTOR OF THE MOON ROCKET.

I believe that the change in title to SCIENCE AND INVENTION of a magazine of the scope of the ELECTRICAL EXPERIMENTER is a good idea.

R. H. GODDARD.

Worcester, Mass.

FROM INSPECTOR J. F. DILLON.

In view of the wonderful development of your excellent publication the change of name appears both timely and appropriate. I have found the ELECTRICAL EXPERIMENTER increasingly instructive and enjoyable, filling a distinct need. May its success be enhanced under the new name.

J. F. DILLON,

San Francisco, Cal. *Radio Inspector.*

FROM CAMP MEADE.

We think new name very good; consider your magazine one of best we have.

U. S. TANK CORPS SCHOOL.

Camp Meade, Md.

FROM THE INVENTOR OF THE AUDION.

I believe that the present name of your journal is a better description than the suggested new title. I do not consider the new title, SCIENCE AND INVENTION, as good as the present one under which you have built up a wonderful circulation and clientele, particularly among youthful experimenters.

LEE DE FOREST.

New York, N. Y.

FROM EDITOR TRASK.

You are doing well, I think, to give your magazine the new name of SCIENCE AND INVENTION, because it foreshadows a wider range of subjects for your readers, while not restricting the field you have so entertainingly and ingeniously filled up to this time.

HERBERT A. TRASK,
Editor Post-Dispatch.

St. Louis, Mo.

FROM N. Y. SUNDAY WORLD.

Why change? You have established a high reputation under your old name and new name is little if any better.

EDITOR, SUNDAY WORLD.

New York, N. Y.

FROM EDITOR JONES.

My! How you've grown. And such a handsome boy, too. Why, I remember you when you were such a delicate child that nobody thought you would live very long and as far as I could see no one cared very much. But you evidently recovered from that infantile weakness and you certainly look all right to me. Your father should be proud of you. And your long pants are very becoming too. The last time I saw you it did occur to me that you had outgrown your clothes but your new suit is certainly a success and will enable you to take your place among real people. Just to think that I can remember when you first came to my office, I used to pick you up and promptly drop you in the waste basket along with the advertising matter. But once the pages accidentally spread open and I saw a picture which arrested my interest and I rescued you from the waste basket and gave you the "once over" and as the result I have been watching for you every month ever since.

GEORGE J. JONES,

Sunday Editor, Philadelphia Inquirer.

Philadelphia, Pa.

FROM EDITOR VALE.

A far better, broader and more comprehensive name is SCIENCE AND INVENTION. Just the kind of a name that carries with it the great field you are handling so entertainingly and so helpfully. Just the sort of a name that will make your publication do bigger things than you already have done. Just the sort of a name that will impel you to greater service and bring larger popularity.

ROBT. B. VALE,
Sunday Editor, North American.

Philadelphia, Pa.

FROM HUDSON MAXIM

I think the new name SCIENCE AND INVENTION most excellent. It has the necessary breadth for your big purposes. The superb work you have done under the title ELECTRICAL EXPERIMENTER is a prophecy and warrant of the splendid character of SCIENCE AND INVENTION.

HUDSON MAXIM.

Hopatcong, N. J.

FROM THOS. S. FORD.

If the magazine is broadening its scope to fit the name SCIENCE AND INVENTION, I should say that the change is a happy one.

THOMAS S. FORD,
Editor Los Angeles Times Magazine.

Los Angeles, Cal.

FROM KANSAS CITY "STAR."

The title ELECTRICAL EXPERIMENTER is obviously inadequate to express the great scope of your field, which is not limited to electricity nor experimentation. I think that the new name of SCIENCE AND INVENTION is much better.

SUNDAY EDITOR,
Kansas City Star.

Kansas City, Mo.

FROM THE INVENTOR OF UNDERGROUND RADIO.

The ELECTRICAL EXPERIMENTER has been an inspiration in a specific scientific realm. Its influence has reacted into the field of science beyond that of experimentation into the larger sphere of general Science and Invention. Please therefore accept my sincere felicitations upon the enlarged scope of the magazine under the new title SCIENCE AND INVENTION. America has won high renown through the scientific labors and inventive genius of many who have made a distinctive contribution to the Republic of Science. The ELECTRICAL EXPERIMENTER in its inspiration to service and its record of accomplishments has rendered definite and far-reaching co-operation.

JAMES HARRIS ROGERS, PH.D.

Washington, D. C.

"Home Electrics"

By G. L. HOADLEY, M. E.

Vibrating Type Bell

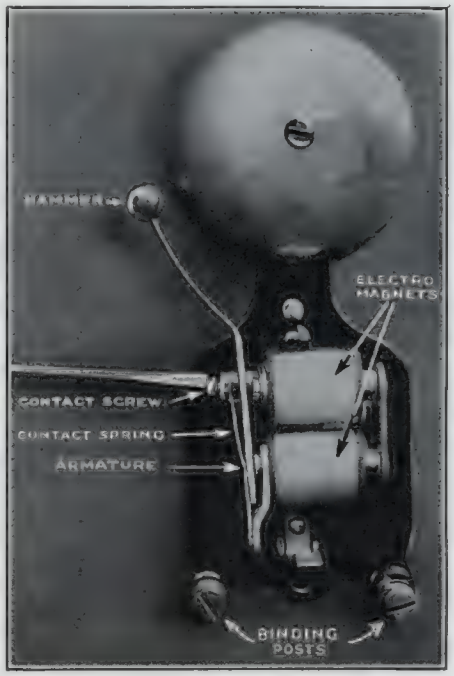
THERE are five different types of bells in general use. Figure 1 shows the vibrating bell which is the one most commonly used. In operating this bell, current enters the binding-post, "a," flows thru the magnet coils, thru the adjusting screw, "c," armature spring, "d," and comes out at binding-post, "a'." The passing of the current thru the coils magnetizes their cores, which attract the armature, "f," drawing it over against them and causing the hammer to hit the gong. This movement of the armature opens the contact between "c" and "d" interrupting the flow of current thru the coils, and causing them to become demagnetized. Spring "d" then pulls the armature back closing contact between "c" and "d" again and the operation is repeated as long as the current continues to flow thru the bell.

SINGLE-STROKE BELL.

An important modification is one by means of which the bell is made to give a single stroke only for each contact with the battery. This is known as the "single-stroke" bell and is shown in Figure 2. One of the cases where it may be used is to transmit preconcerted signals; it is also used in series with the vibrating bell, and when so used both bells must have the same natural periods of vibration; that is, the armatures, tappers, and springs should have the same weight, dimensions, and construction. While the "vibrating" bell can be changed to operate as a "single-stroke" bell by so adjusting the vibrating contact screw that the circuit will not be opened when the armature is drawn over, better results will be obtained by using the "single-stroke" bell, which differs from the "vibrating" type in the manner in which the magnets are connected up to the binding-screws. A careful examination of Figure 2 will show the wires from the magnets go direct to the binding-posts for the "single-stroke" bell so that when contact is made the armature is drawn over against the magnet cores and held there as long as the battery current passes. In Figure 1 the circuit for the "vibrating" bell is completed thru the platinum screw pillar to the binding screw, hence the circuit is rapidly made and broken so long as contact is made with the battery.

COMBINATION SINGLE-STROKE AND VIBRATING BELL.

This bell combines both previous types and may be used for either purpose by properly connecting it. Figure 3 shows its connections. A two-point switch is used to throw into circuit either leads "a" and "b" or leads "a" and "c." When "a" and "b" are



All of the Principal Parts of the Vibrating Electric Bell Are Here Lettered on an Actual Photograph of a Bell—Giving a Clear Idea of Its Make-up.

in circuit the "single-stroke" bell results; while "a" and "c" will give the "vibrating" type.

SERIES OR SHUNTING BELL.

In this type of bell shown in Figure 4, each time the armature is drawn over it strikes a contact which establishes the shunt path "a," "b," "c," "d," "e" around the magnets thru which the current flows rather than thru the bell magnets. This demagnetizes the magnets allowing the armature spring to pull the armature back again, breaking contact "c" and the operation is again repeated. The purpose of bells of this type is to reduce arcing at the vibrating contact, especially on circuits where the electro motive force exceeds five volts.

THE DIFFERENTIAL BELL.

This type of bell, illustrated in Figure 5, is intended mainly for use on circuits of relatively high voltage. Its magnets are wound differentially, that is, so one winding opposes the other. When the circuit is closed one winding is energized and the armature is pulled over to the cores, making contact at "c." This contact at "c" completes the circuit for the second winding, and since the two oppose, the resultant magnetism is reduced to zero. This allows the armature to be drawn back by its spring and the operation is ready to be again repeated.

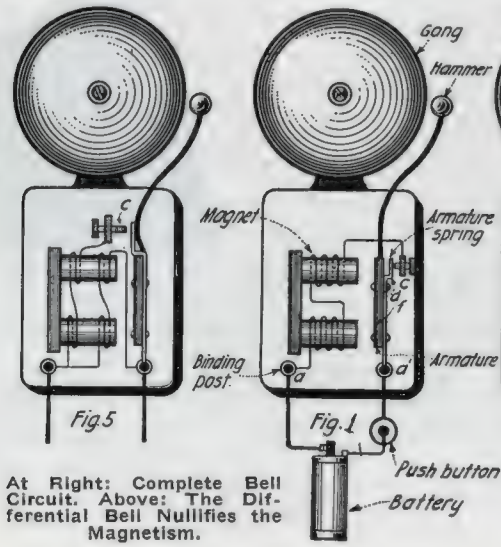
CONTINUOUS RINGING BELL.

In this type, illustrated by Figure 6, the ringing action, when once started, continues until stopt by the person in charge. It is greatly used in cases of burglar alarms, engine rooms, watchman's alarms, telephone central offices, etc. It differs but little from the ordinary vibrating type of bell. In Figure 6 the closing of the circuit causes the magnets to draw the armature over and release the latch, allowing it to drop down by gravity or be pulled down by a spring on the contact point "p." A shunt circuit is thus established around the push button and the bell continues to ring until the latch is restored by hand.

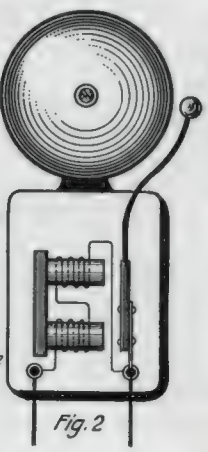
BELL TROUBLES.

Before you hunt for bell troubles, be very sure that your batteries are good and not run down. Batteries, as a rule, are the seat of most bell troubles. Bad contacts are frequently the cause of failure of the bell to ring. Wiremen sometimes simply wrap the terminal wires around the base of the binding screws. This greatly increases the resistance of the wires. Care should be taken to see that the terminal wires are firmly held underneath the binding screws. Again, chloride of zinc is used sometimes as a flux to make a soldered contact at the junction points of the wires with the contact angle brass and contact pillar. This speedily rots the wire and spoils the insulation of the adjacent parts. Soldered joints are certainly desirable, but only resin flux should be used. Corrosion of the contacts at the spark gap is quite common in cheap bells where German silver, platinoids, silver or some white metal is used instead of platinum or iridium. This destroys the continuity of contact.

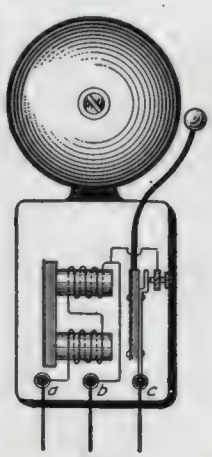
(*Continued on page* 454)



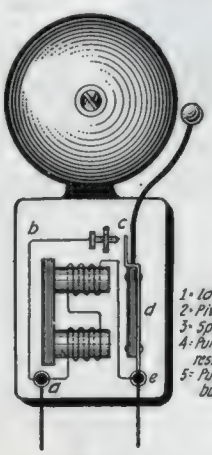
At Right: Complete Bell Circuit. Above: The Differential Bell Nullifies the Magnetism.



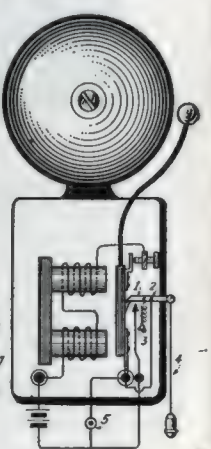
Above We See the "Single Stroke" Bell.



Here is a Handy Bell—Works Single Stroke or Vibrating.



Here We Have the "Shunting" or Short-Circuiting Bell.



Automatic Switch for Continuous Ringing Bell.

News for "Straphangers"

The new safety car straps here illustrated are formed of a leather strip which is bifurcated and spread apart at a point immediately above the rounded hand-loop, as shown, so as to form a V-shaped strap whose upper extremities are permanently separated a distance of about ten inches by means of an invisible spring-metal spreader that spans the same at a point just behind the running rod. The spreader and strap together constitute a triangle, which is capable of being freely shifted along the running rod by slightly lifting the strap, but which cannot of itself move under the influence of the motion of the car or train. "Bunching" of the straps is therefore not only naturally avoided, but is furthermore prevented by the V-shaped formation of the straps themselves, which insures at all times their proper spacing and uniform distribution thruout the length of the car.

The sides of the straps diverge at such an angle that the direction in which the passenger tends to move under the influence of momentum or inertia is substantially coincident or in a direct line therewith. Consequently, unlike that of the ordinary strap, the hand loop not only forms a fixed support for the passenger, but any tendency on his part to forward or backward motion will at once be resolved into a direct pull or increased tension upon one or the other side of the strap in a prolongation of the direction in which such side is already inclined, thereby making the strap automatically self-bracing, and avoiding all swaying or lurching of the passenger in either direction, and giving him an absolutely firm footing.

In other words, the point of support of the passenger is fixt at the hand loop, as it should be, and not, as in the case of the ordinary strap, at its pivotal support upon the running bar, which latter is generally a foot or more above the point where the strap is grasped. The widely divergent sides of the strap not only prevent forward and backward motion, but serve also to steady the passenger against side motions, such as are produced in turning curves, since they absolutely confine any tendency to lateral movement of the hand loop to a small vertical arc directly in line therewith, thus eliminating the circular horizontal swing of the ordinary strap. Owing to the arc of the circle described by the freely suspended hand loop of the ordinary straps (whether running on straight sections or curves), these straps afford at best a fugitive hold that usually becomes effective only after the passenger has lost his equilibrium. That is productive of great muscular and physical strain, to say nothing of other discomforts that are only too well understood to require further comment.

The spreader that bridges the upper extremities of the car strap can be furnished of spring sheet-metal, arranged in the form of a continuous clip for holding an advertising card, as shown in the illustration.

A Novel Invention is This Idea for Swinging Car Straps. The Strap Swings Only Sidewise and Not Lengthwise of the Car, and at the Top of Each Appears an Advertising Sign.

Electric Lighted Roses in Rose Festival

The metal roses used by Portland, Oregon, for decorative lighting for the Rose Festival were develop as a result of a general demand for something new—something with plenty of light and color.

The metal rose herewith pictured was the result. The roses were approximately 30 inches in diameter and about the same in height. The upper part of the calyx of the rose was formed about a mogul lamp socket, in which was mounted, when finished, a 1,000-watt, bowl-frosted, type C tungsten lamp. There were three circular rows of petals surrounding the lamp, the outer row being carried up to form the body or cup of the blossom. The petals and body of the rose were made of standard gage tinned sheet iron, cut and formed in shape and soldered together. These ro when assembled were painted the color lected for the rose; some were red, so pink and some yellow, and the sepals w painted the proper shade of green on upper or outside of the rose body. T stem consists of a seven or eight-foot ha pole, 1½ inches to 2 inches in diameter the larger end. The natural branches w cut off and two sprays of five metal lea each were mounted on wire stems and tached to the main wooden stem of rose. The leaves, about six inches by n inches in dimension, were cut from bla sheet iron stamped for the veins, solde to wire stems and painted a leaf green

Electrically Lighted Roses Like This One, Measuring Thirty Inches in Diameter, Were Used in Decorating for the "Rose Festival" at Portland, Oregon, With Remarkably Beautiful Results.

Electric Pencil Retouches Negatives

The Work of the Photographic Retoucher is Hard Enough at Its Best, and Anything That Tends to Make His Work More Easily Performed and Attractive is a Boon to the Profession Indeed. By Means of the New Electric Vibratory Pencil Here Shown, and Which Can Be Connected to Any Electric Light Socket, the Retouching Work Can Be Accomplisht With a Minimum of Labor and Time and With Much Superior Results to the Older Method.

An electric vibrator in the design of pencil is now being used for retouchi negatives. It does its work noiselessly a much faster than when done by ha When doing this work the workman usua holds his head, and consequently his ea very near the work. For this reason inventor of this device has succeeded making its operation noiseless. Wh operating, it is held in the fingers much the ordinary lead pencil. Connection electric lighting socket is all that is quired for its operation.

It is a most peculiar fact when we s to think about it, that the realm of photographer has been invaded but li by the electrical inventor. Electricity permeated our household, office and facto thru and thru,—we have electrical ci lighters, curling iron heaters, fireless co ers, stoves, shaving mug heaters, and w not,—but the laboratory of the phot rapher has witnessed but little benefit

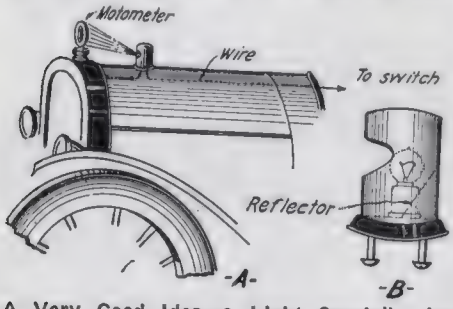
K. H. Hamilton.

MOTOR HINTS

First Prize $25.00.

HOW TO SEE THE MOTOMETER AT NIGHT.

A friend of mine who owns a car came to me complaining that he could not see his "motometer" which is on the radiator cap, when he drove his car at night, and since



A Very Good Idea—a Light Specially Arranged to Illuminate the Motometer at Night. It is Fed with Current from the Storage Battery.

he drove more at night than during the day, I rigged up the following device for him:

First I procured a regular cowl light and black-enameled the inside of it. I then took a piece of bright tin and made a reflector from it, setting it at a forty-five degree angle as shown. After this, I cut a hole in the hood and fastened the light on it. I then attached one wire from the light to a switch and from the positive pole of the battery, to the switch. I ran the other wire to the radiator and soldered it on so as to secure a good connection.

My friend states that the light is giving him excellent service.

Contributed by BILL HOWARD.

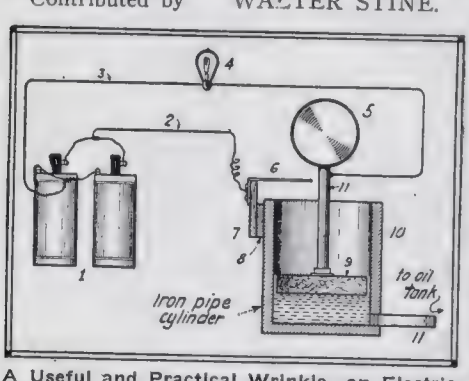
Second Prize $15.00.

GAGE FOR INDICATING LOW SUPPLY OF OIL.

The numbers in the diagram represent the following: 1—Battery; 2—Wire to brass strip; 3—Wire to light and to battery; 4—Electric light to burn when the brass plate 5 goes down on the brass strip 6, when connection is made and the signal light will burn. When the oil gets low the cork 9 will sink and light lamp; 10—The chamber made of one inch pipe.

The disc 5 is made of brass, and 6 is also made of the same material. 8 is a piece of wood so it doesn't make contact with 10. 7 is a bolt or screw with which it is fastened. The screws have gum washers around the bolts, and also on the outside. 11 will fit in the transmission of the Ford car. Just screw one of the lower spigots out, and screw this in. Precaution should be taken to get the right position of the cork, and after it is set correctly, it will work properly. The stem must have two nuts on it to adjust it up and down.

Contributed by WALTER STINE.



A Useful and Practical Wrinkle—an Electric Alarm to Indicate "Low" Oil in the Engine Crankcase.

$50.00 IN PRIZES. Paid for "Motor Hints."

Most of our readers have a car of their own, and any number of them have made certain improvements on that car. We want to know about these improvements. What we want are PRACTICAL ideas, not freak stunts. The idea should be simple enough, so that anyone handy with tools can duplicate it. Note that the idea does not necessarily have to be electrical in any way.

We would like to have a photograph of the stunt showing that it was actually tried, but this is not absolutely necessary to win a prize. A simple sketch will do showing the essential parts, etc.

We will pay the following prizes each month:

FIRST PRIZE	$25.00
SECOND PRIZE	15.00
THIRD PRIZE	10.00

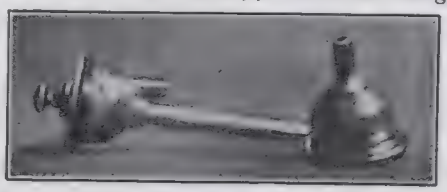
All other accepted articles, which win no prizes will be paid for at the rate of $2.00. Articles submitted should not be long ones. About one hundred to two hundreds words will suffice. Address all manuscripts to Editor, "Motor Hints," care of this publication.

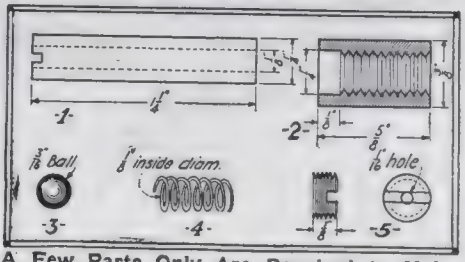
Third Prize $10.00.

PREVENTING WASTE BY EVAPORATION.

The materials of which it is constructed are easily procured from the workshop scrap-pile. A piece of 3/8th inch brass rod, 5/8th inch long (Fig. 2), is drilled lengthwise with a 3/16th inch drill, and tapt with a 1/4 inch-18 tap; one end is then drilled for a distance of 1/8th inch, with a 1/4 inch drill.

Next take a piece of 1/4 inch brass tubing,





A Few Parts Only Are Required to Make This Gas Vent Which Prevents Loss of Gas by Evaporation.

1¼ inches long (Fig. 1), slot one end about 1/16th inch deep with a hack saw, and file the other end absolutely square, as this is to be the *valve seat.*

Make a spiral spring by winding 8 turns of No. 22 gage hard drawn copper wire (phosphor bronze best) on a 1/8th inch diameter nail or rod, with a pitch of about 3/32 inch; fully compress the coil while still upon the rod and release instantly.

The other parts required are a 3/16th inch ball bearing, such as are used in roller skates, and a small piece of 1/4 inch stove bolt, about 2 whole threads, having a screwdriver slot cut in one end and a 1/16th inch hole drilled thru it.

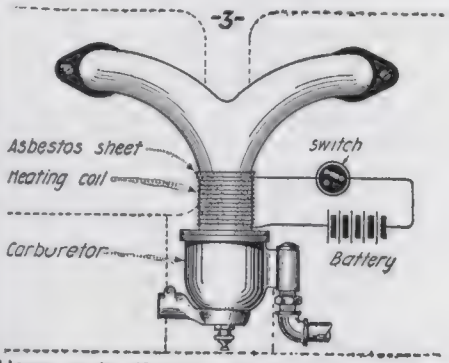
In assembling, the brass tube is inserted in the 3/8 inch rod and soldered. The valve seat and ball are cleaned, the ball placed on the seat and tapt with a hammer (the brass being soft will give), thereby forming a good joint. The spring and screw are inserted and the whole assembly soldered to the tank cap as illustrated in the photo.

The spring is adjusted to suit the user. In the valves I made, they are adjusted to open every time two ounces of gas flows out of the tank.

Contributed by C. H. OELSCHLEGEL.

ELECTRIC MANIFOLD HEATER.

The following device has proven useful in helping to vaporize the gas from the carburetor in damp, chilly weather.



Home-made Electric Manifold Heater for Quick Starting of Auto.

The principal thing to watch in carrying out this arrangement, is to see that the resistance coil is not made so that it will draw enough current to injure the battery. With an ammeter in series with the coil and battery when making the first test or two, this point can be readily watched and guarded against, by using a greater length of wire or a smaller size of wire. A layer of 1/16th inch asbestos is placed tightly around the manifold intake pipe, leading from the carburetor to the engine, as shown, and over this is wound one or more layers of resistance wire, if this is available. Iron wire or German silver could be used and several sizes may be employed, such as No. 26 to No. 28, depending upon what kind of wire is used and the voltage of the battery. Wrap asbestos around coil.

Not over 8 to 10 amperes are necessary, usually, with an 8 to 12-volt battery. This current has only to be turned on for a few minutes.

Contributed by H. SECTOR.

VACUUM CARBON CLEANER.

The vacuum cleaner helps the work of quickly removing carbon from automobile cylinders. Scrapers first loosen the carbon, and the vacuum attachment is then put into the spark plug gap to suck the carbon out.

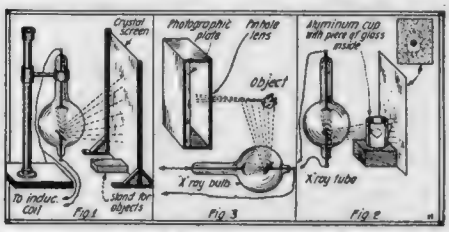
Photo by EDNA PURDY.

Using Vacuum Cleaner to Remove Carbon from Engine.

Little Known X-Ray Facts

By PHILIP A. WALL

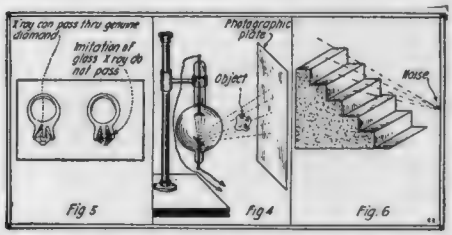
PROFESSOR DAVID LOCKE WEBSTER, well known physicist, especially among college students, certainly justified the title of Popular Experimental Science Lecture when he commenced the series of lectures, on March 5, by giving a highly interesting



Some Interesting Side-Lights on X-Rays. 1, Shows Stand for Objects to Be Examined and Which Are Always Placed Between the X-Ray Bulb and the Fluorescent Screen on Which the X-Ray Image Is Thrown. The Observer, of Course, Stands on the Far Side of the Screen—i.e., the Screen Lies Between the Observer and the Object to Be X-Rayed.

lecture on the difficult subject—"X-rays." The Masachusetts Institute of Technology, famous for its high standard of scientific education, presents every year a course of lectures, one a month, on various scientific subjects, these lectures being attended by members of physics and chemistry classes in nearby High Schools

The course of lectures this year was named, Popular Experimental Science Lectures, and as was said, Prof. Webster certainly justified the title, dealing with the broad subject of "X-rays" in such a clear and interesting manner that the lecture was thoroly enjoyed and understood by all who attended. Prof. Webster's lecture was filled with a great many experiments and also with skillful touches of humor, now and then.



Diamonds Can Be Tested by Means of the X-Ray as Shown at 5. A Set of Stone Steps, by Diffraction, Turns a Noise Into a Musical Note, Fig. 6. X-Rays, However, Are Only Diffracted by Very Small Particles or Crystals.

A brief synopsis of Prof. Webster's speech is as follows:

Altho X-rays are known generally to people in the form of photographs, X-rays themselves are invisible and are only seen by viewing them thru a fluoroscope or a screen coated with barium-platinum-cyanide crystals. (See Fig. 1.) X-rays will pass thru wood and metal in varying degrees, according to the power of the tube and the thickness of the object, but X-rays are completely stopt by glass. (Figs. 2 and 3.) X-rays are not bent as ordinary light, but are perfectly straight and thus produce well defined shadows. By these shadows the popular X-ray photos are made and are now found to be of great use by dentists and doctors besides being used in small capacities by most every scientific man. (Fig. 4.) X-rays are varied by the circumstances—thus heavy substances stop X-rays more than light ones and the X-rays themselves may be *hard* or *soft* meaning high powered or low, depending on whether the voltage applied to the tube is comparatively high or low. Usually X-ray photos are made by direct shadows but they may also be made by *scattered* or *reflected* rays. (Fig. 5.)

By diffraction, a set of stone steps turns a noise into a musical note. (Figure 6.) Similarly with light which is diffracted by the diffraction grating X-rays, however, are only diffracted by very small particles of crystals. (Fig. 8.) X-rays, the same as light and sound, have wave lengths and vibration but very much smaller than either of these. The atoms of an X-ray are so small that if a drop of water was magnified to the size of the earth the X-ray atom would appear large enough to see. The X-rays are high speed electrons, ionized by the passage of a current of high voltage thru a vacuum.

We all know or have seen pictures of the X-ray tube. The green light in the tube itself *is not due* to the X-rays but merely the passage of a current in a vacuum. The vacuum tube must have reached a certain stage of exhaustion before the X-ray effect takes place. If a tube of air is slowly exhausted and a high voltage current past thru the tube, the discharge will change from a plain loud spark to different kinds of violet light and then to greenish light. At this greenish light stage, when but 1/100,000th part of the air remains in the tube, the X-ray effect occurs. (Fig. 9.) The flow of ions is from the anode to the cathode. The cathode in the X-ray tube is a concave mirror, which reflects or deflects the stream of ions. The reflected rays, called *cathode rays*, travel to the side of the tube and the X-rays are produced by the impact of the cathode rays with the glass of the tube. If a magnet is brought near an X-ray bulb, the cathode

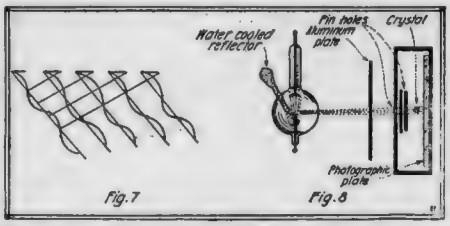


Fig. 7. Illustrating Diffraction of Noise (Sound) by a Picket Fence. Fig. 8 Shows Arrangement of High-Power X-Ray Tube With Lens Holes in Plates and Position of Crystal for Test by X-Ray Diffraction.

ray will be attracted or repelled, thus showing that this ray is a current of electricity. These rays travel fast enough to go around the world several times in a second. X-rays, like other branches of science, are open for new advances both in method of production and use of the ray.

Prof. Webster closed his lecture by showing the beautiful lighting effect of the Coolidge X-ray tube. He also stated that any members of the audience, interested, might experiment after the lecture with the extensive apparatus he used and many young experimenters took advantage of this fact to use high priced apparatus which otherwise they could only read about. Prof. Webster's lecture was so interesting and so filled with experiments that the hour past only too soon as it was enjoyed by all his audience.

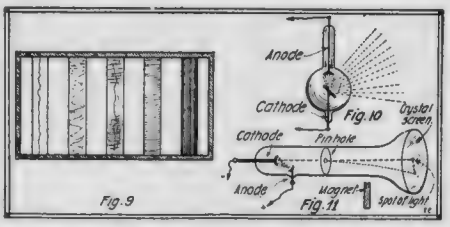


Fig. 9. Rack of Vacuum Tubes of Varying Degrees of Vacuum Used by Prof. Webster to Illustrate Change of Discharge According to Vacuum. Fig. 11. Special Vacuum Tube Used by Prof. Webster to Show That the X-Rays May Be Repelled or Attracted by a Magnet.

Radium Production

During the period of the war, with no carnotite exports, the greatest part of the world's radium supply has been produced in the United States. The following table shows the radium output of the Standard Chemical Company, of Pittsburg, Pa., since 1913, at which time radium was first produced in the United States.

	Radium Element, Grams.
1913	2.1
1914	9.6
1915	1.7
1916	5.0
1917	7.0
1918	13.6
	39.0

It is estimated that the total radium production in the United States to 1919 approximates 55 grams of radium element, and this represents, probably, more than half of all the radium produced in the world.

There has been some discussion lately by members of the Bureau of Mines as to the amount of radium that can be produced from the carnotite fields, as well as suggestions that *mesothorium*, a by-product from monazite, should replace radium in the luminous material which has found extensive use in the war on airplane and ship instrument dials, compasses, and many indicating devices, and which will find extensive use on watches and clocks, etc.

The estimates of Dr. Moore," of the Bureau of Mines, are based on a very inadequate study of the carnotite region made prior to the war and before the fields had been developed to any great extent. The carnotite holdings of the Standard Chemical Company, which are the largest under the control of a single company or individual and comprising about 350 claims, have been carefully studied—in part by systematic diamond drilling—and this work has been the basis for an estimate that at the least 500 grams of radium should be produced from carnotite. This is five times greater than Dr. Moore's estimate.

There is much speculation rife, however, as to the total radium supply available in the United States, and owing to the rapid production of the precious substance lately it is thought that our supply may soon be exhausted, or at least markedly reduced.

Popular Astronomy

By ISABEL M. LEWIS, M. A.

Of the U. S. Naval Observatory

Double and Multiple Stars

THE plan of the solar system, which is that of a central sun encircled by satellites that are far inferior to their luminary in size, and that move about it in orbits that are almost perfect circles, is not the only, nor in fact even the most general one that prevails thruout the Universe.

Sweeping the heavens with powerful telescopes one is astonished to find that myriads of stars can be separated into two or more physically connected suns that are often, moreover, of exquisitely tinted and contrasting hues. Green and red, orange and blue, white and golden or white and blue pairs exist in profusion, and strange to say there are well-authenticated instances of color changes taking place temporarily within the same system. A pair of white stars has been known to change within a few decades, first to golden yellow and bluish green and then to orange and green. The famous pair catalogued as "95 Herculis" was noted to change from green and red to a paleish yellow and back to the original strongly contrasting hues within the course of a single year, while at another time they shone as a perfectly white pair. At the present time both of these stars are strongly yellowish in color. Such changes in hue are probably due to temporary disturbances in the atmospheres of the stars, possibly of an electrical nature or due to sudden or unusual outbursts of activity, concerning the origin of which we are as much in doubt as we are of the cause of the sunspot cycle and periodic variation in the intensity of radiation of our own sun. Temporary changes in the color of the components of double star systems sometimes take place when the two stars approach their "periastron" or point of nearest approach. Owing to the great eccentricity of the orbits of double stars, such stars are anywhere from twice to nineteen times as near to each other at periastron as they are at "apastron," or point of greatest departure. Such pronounced changes in the relative distances of two physically connected suns would produce marked changes in the intensity of the tides raised upon each of them by their mutual gravitational attraction and unusual outbursts of gases or electrical excitement in the atmospheres of the stars might cause very noticeable changes in the color of these stars as they drew nearer to each other, which would subside as they receded toward apastron.

In addition to "visual" double or multiple stars, there exists a very extensive class of stars known as "spectroscopic binaries," in which the two components are so close to each other *that even the most powerful telescopes cannot divide them!* It is only from the shifting of the lines of their overlapping spectra, caused by their alternate motion toward and from the earth as they revolve about their common center of gravity, that their *duplex* nature is revealed to us.

In some instances one member of the system is so faint that its spectrum is not visible and its presence is disclosed only by the shifting of the lines of the bright star.

According to Doppler's Law, when a star is approaching the earth the lines of its spectrum shift toward the blue end of the spectrum, and when the star is receding from the earth the lines are shifted toward the red end of the spectrum. The amount

We Are So Used to Our Sun That It Never Occurs to Us That There Are Other Worlds Which Have Multiple Suns. As a Matter of Fact, the Solar System May Be Called an Exception as We Find Thruout the Stellar Universe That There Are Many Star Systems Having Two or More Suns. Herewith Is an Illustration How a Planet of Such a Double Star System Looks to the Inhabitants,—if Any—on Such a World. The Two Suns, Due to the Tremendous Mutual Gravitation Attraction Are Pulled Into Elliptical Shape as Shown. Tremendous Tidal Effects Will Be Created on the Planet, Providing, of Course, This Planet Has Water as Our Earth Has. The Two Suns Also Give Rise to Peculiar Shadow Effects Whereby Every Object Throws Two Shadows Instead of One.

Here We See a Repetition of the Planet Shown in Our Other Illustration With the Difference That the Two Suns Have Now Drawn Apart for a Considerable Distance. The Two Suns Rotating Around Each Other Sometimes Come Within a Few Million Miles Together and at Other Times Draw Apart for a Considerably Greater Distance. The Planet Attached to One of the Suns Consequently Will Have the Peculiar Phenomenon of Having Two Suns Close Together In the Skies as Shown In the Other Illustration and at Other Times the Suns Will Be Quite Far Apart, as Shown In the Above Illustration. These Two Suns Give Tremendous Tidal Effects Upon the Planet and Life if It Exists on Such a Planet Will Be Anything But Safe on Such a World.

of this shift can be very accurately measured, and gives the relative velocities of the stars in their orbits directly in miles per second. Knowing in addition, by observation, the period of mutual revolution of the stars, it is possible to find the dimensions of these spectroscopic binary systems compared to our own solar system, and also the masses of the stars compared to the mass of our own sun. If the spectrum of the fainter star is not visible, only the velocity of the brighter star with respect to the center of gravity of the system can be found and the mass found for the system comes out too small. In such cases we can obtain only a lower limit for the mass of the system. Then, too, it must be remembered that these systems of stars lie at all angles with reference to our line of sight, and so we rarely see the orbits in their true form. The *measured* velocities are as a result smaller than the *true* velocities, and on the average amount to only sixty per cent of the true orbital velocities. The calculated masses of spectroscopic binary stars are, therefore, in general only about sixty per cent of the true masses. Strange to say, it has been found from calculating the masses of a number of binary systems, that the combined masses of the stars in these systems do not differ very greatly among themselves, nor as compared to our own sun, tho in *light-giving power* stars may differ hundreds, thousands, even millions of times. For instance, there are stars that give only *one ten-thousandth part* of the light of our own sun, and other stars that give *ten thousand times as much* light as the sun. Still stranger, there are many instances of physically-connected stars differing *thousands* of times in luminosity, tho in mass, or quantity of matter found in the stars, they differ only *two or three* times. Why this is so remains one of the great mysteries of the heavens, and makes it extremely difficult to give any satisfactory theory of the origin of double-star systems. No theory so far advanced has explained satisfactorily why of two suns physically connected and, therefore, presumably originating at the same time, one should be radiating with maximum intensity, while the other is practically an extinct sun, tho *the quantity of matter* in the two bodies differs but slightly.

In a few systems the plane in which the stars revolve passes so nearly thru the earth that the two stars temporarily eclipse one another during each revolution. Such systems are referred to as *eclipsing binaries.* To such a system belongs the famous *Algol.* Its light waxes and wanes periodically with the greatest punctuality in a period of $2^d\ 20^h\ 48.9^m$, owing to its temporary eclipse by a very large but extremely faint attendant sun. The diameter of the faint star is slightly greater than the diameter of the bright star which has a value of about one million miles. The distance between the *centers* of the stars is only about three million miles, which brings their *surfaces* within two million miles of each other. The masses of the two stars are in the ratio of two to one, the brighter and more massive star being about half as heavy as our own sun, tho its density is only about *two-tenths* that of the sun. The density of the fainter star is still less, being only about half that of the brighter star. Very low density for both components and extreme faintness of one member compared to the other, appears to be a very general characteristic of closely associated eclipsing and spectroscopic binaries. Among the extremely hot and brilliant helium and hydrogen stars, spectroscopic binaries exist in great numbers. In fact, among these types there appear to be as many binary and multiple systems as there are systems of isolated suns. Sometimes these close binary stars are egg-shaped or oval and revolve rapidly almost in contact about their common center of gravity. Inhabitants of satellites of such a system would see in their heavens the, to us, strange and startling phenomenon of *two* suns, each equal to our own or even greater in size, whirling rapidly about each other and separated by a space comparable in extent to their own diameters. Eclipses in such a system would be of daily occurrence, and, if one star were dark, would produce for the satellite world the same effect of alternate day and night that results from axial rotation of a satellite. The two hemispheres of the faint companion sun would be very unequally illuminated owing to the fact that the side turned toward the brilliant sun would always reflect its neighbor's brightness in addition to shining with its own comparatively feeble inherent light, while the opposite hemisphere would shine only by its own dim light, and would, therefore, be in comparative darkness.

The spectroscopic binaries generally revolve closely and rapidly about their common center of gravity; there are to be found, on the other hand, among the wider *visual* doubles, many systems wherein the components are separated by distances comparable to the distances of the outer planets, Saturn, Uranus and Neptune, from the sun. It is evident that the individual components of such binary systems could not possibly be encircled by any such extensive system of satellites as attends our own sun, tho satellites such as our own planet Earth, or the inferior planets Mercury and Venus, might conceivably encircle the individual components of such binary systems at distances not greater than that of the earth from the sun. No planet could safely exist at a much greater distance from one of these suns without being subject to most dangerous perturbations and disruptive tidal forces arising from the vicinity of the second sun. Granted that planets might encircle one of these suns at a distance approximating that of Venus or our own planet from the sun, the inhabitants of such worlds would behold the strange phenomenon of *two* suns in the heavens, not always almost in contact as in spectroscopic binary systems, but at one time comparatively near and again in opposite portions of the heavens as is the case with the sun and moon in our own heavens. As the planet advanced in its orbit about

(*Continued on page* 419)

Practical Chemical Experiments

By PROF. FLOYD L. DARROW

CHEMICAL EFFECTS OF THE ELECTRIC CURRENT

Electrolysis of Sodium Sulfate Solution, Using the Bichromate Cell as a Source of Current.

Charging a Simple Storage Cell, Consisting of Two Lead Strips in Dilute Sulfuric Acid.

SINCE Sir Humphrey Davy, working in the laboratory of the Royal Institution in London, more than a century ago, first used the electric current for chemical purposes, the application of electricity to the solution of chemical problems has revolutionized the science and introduced a host of new processes. In this article we shall take up some of the chemical applications of the electric current which can be carried out in the "Home Laboratory."

Source of Current: The electric current itself was chemical in its origin and is even yet for a myriad of purposes. When Luigi Galvani late in the eighteenth century caused the twitching of the frog's legs in his now historic experiment, altho he did not know it, the production of the current that caused the twitching was due to chemical action. Alexander Volta soon after made the first electric cell, and from that day to this the world has not been without these highly important cogs in the machinery of modern industry. For nearly a century *dynamic* electricity was unknown and the only source was batteries.

In your own laboratory you may be fortunate enough to have direct current from your house-lighting circuit of a voltage suitable for experimental work. If the current is alternating, however, it is unavailable and, even if direct, for most experiments a considerable resistance will have to be connected in series with it. Therefore, it will be to your advantage to know how to make a battery of cells that will give you sufficient voltage and current for most work.

The Bichromate Cell: This cell gives the highest voltage of any of them and is best for home laboratory work. If you prefer, the containers, carbons and zincs for these cells can be purchased but if not, then secure a half dozen fruit jars for the containers. Then dissect some old worn out dry cells and remove the carbons leaving the binding posts intact. Secure strips of heavy zinc equal in length to the carbons and about an inch and a half or two inches wide. To each zinc solder a binding post. In each jar place 710 cubic centimeters (about a pint and a half) of water and dissolve in it 80 grams of chromic acid. Then slowly add with constant stirring 45 cubic centimeters of concentrated sulfuric acid. Provide a holding clamp for each electrode and place the zinc and carbon in the jar. The clamps may be made from two strips of wood with bolts and thumb screws at each end. See Fig. 1. A half dozen of these cells connected in series, i. e., with the carbon of one joined to the zinc of the next, will give sufficient voltage for a large number of experiments. When these cells are not in use the zincs must be removed from the jar or they will soon be eaten away and this action destroys the acid, too.

Electrolysis: This term covers a large number of applications of the electric current but we shall consider first the determination of what substances are electrolytes and what ones are non-electrolytes. An electrolyte is a compound that in solution in water will conduct the current.

Producing Hydrogen and Oxygen by the Electrolysis of Water.

For this work a simple electrolysis apparatus will be necessary and it will be fully as cheap and much more satisfactory to buy one of the simpler pieces from an apparatus company than to attempt to make one. In an apparatus such as that shown in Figure 2 place some distilled water and connect with your battery of cells. Note whether bubbles appear about either of the platinum electrodes. If not, the water is a non-conductor and as the chemist says does not *ionize,* or break up in solution into small *positively* and *negatively* charged particles called ions.

If you have direct current in your laboratory of 110 volts, connect this with your electrolysis apparatus, having in series with it a 40-watt lamp. Then, whenever you have an electrolyte which ionizes to any great extent, *enough current will pass to light the lamp.*

Next place in your apparatus a little alcohol (denatured will be satisfactory) and pass the current. Is it an electrolyte? Repeat using a little glycerin dissolved in water. Result? Rinse out the apparatus and place in it solution of sugar. Determine whether this conducts the current. Prepare a solution of acetic acid and water, or vinegar and water, and try to pass the current. You will have better success in this case but still there will not be much evidence of action. These substances are all organic and one of the distinguishing characteristics of such compounds is that they are *non-electrolytes.*

Now rinse out the apparatus several times and try the action of the current on tap water or spigot. If you see bubbles, it will be due to the presence of mineral matter in the water. Indeed, by the quantity of current that passes considerable can be told as to the amount of mineral matter in the water.

In dilute sulfuric acid (1 of acid to 10 of water, always pouring the acid into the water) you will find a real electrolyte. This time close the pinchcocks on the rubber tubing at the top of the collecting tubes and allow the current to flow until a considerable quantity of gas has collected in each. Note that there is about twice as much gas in one tube as in the other. Over this one invert a test tube and carefully open the pinchcock, allowing the gas to rise into it. Quickly bring the mouth of the test tube to the flame of a Bunsen burner and a sharp explosion will follow. This gas is *hydrogen.* Over the other pinchcock bring a glowing

Making an Electrotype With a Single Storage Cell as the Source of Current.

splint and very slowly allow the gas to escape. The splint will be kindled into a flame showing the gas to be *oxygen.*

Electrolysis of Sodium Sulfate Solution: Prepare a strong solution of sodium sulfate

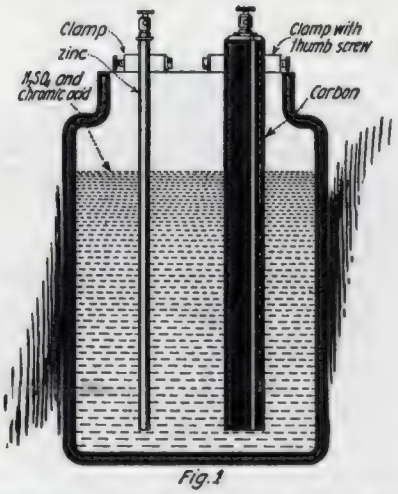


Fig. 1

The Students' Bichromate or Chromic Acid Battery Cell. Easy to Make and Yielding a High Voltage.

and in it place enough blue litmus solution to color it distinctly. Pour some of it into the apparatus used in the previous experiments and connect with your battery or direct current. Bubbles will at once appear copiously at each electrode and very shortly the liquid in one of the tubes will turn red while that in the other will become a deeper blue. Reverse the connections and in a few moments the color changes will also reverse. This is due to the fact that at the cathode, or negative electrode, sodium hydroxid, a base, forms, while at the anode, or positive electrode, sulfuric acid forms.

Other compounds may also be tested in the apparatus but do not attempt to electrolyze sodium chloride, for the chlorine liberated will attack the platinum and ruin it.

Making an Electrotype: Where a large number of copies of any publication are to be printed the soft type metal is not durable enough to give clean-cut impressions. Therefore copper electrotypes are made and the plates become permanent.

On a strip of lead 3 inches by 4 inches place lumps of beeswax and melt them over a small Bunsen flame. Allow the beeswax to run evenly over the sheet of lead and harden into a layer about ⅛ of an inch thick.

When the wax is hard rub it over thoroly with powdered grafite, using a soft cloth. Dust the object you wish to electrotype—example, some metallic souvenir stamped with an inscription and figure—and press it firmly into the wax until a deep clean-cut impression is made. Fig. 3 A. Now dust this impression again with grafite and rub to a smooth shiny surface. Attach a wire to a hole in the top of the lead strip and be sure the grafite extends onto the lead so as to make a continuous conducting surface.

Then prepare a copper plating bath. An oblong glass jar similar to that shown in Figure 3 is best. Fill this two thirds full of a saturated solution of copper sulfate, prepared by shaking the pulverized crystals into a two liter bottle of water at frequent intervals for a considerable period. At one end of the jar, as shown in Fig. 3, hang the lead plate and at the other a sheet of copper having the same area as the lead. Connect these plates with two gravity cells or one storage cell, being sure that the lead plate is joined to the negative pole. Allow the current to flow for at least 24 hours, and 48 will be better. A small steady current for a long period of time will give a firm, evenly deposited layer of copper on the grafite surface.

At the end of the period remove the lead plate and very carefully strip off the layer of copper, having first immersed it in hot water to loosen it from the wax. To make the electrotype permanent it will require backing with melted tin. To do this make a small form from molding clay of the exact size of the electrotype and about a quarter of an inch in depth. Make the bottom perfectly smooth and horizontal. Place the electrotype face down in this form being careful to have the edges fit tight up to the sides. Place the form in an oven and

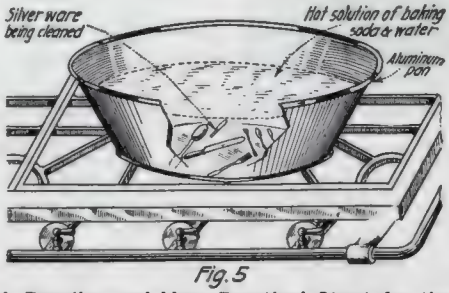


Fig. 5

A Peculiar and Very Practical Stunt for the Home—Cleaning Silverware in an Aluminum Pan.

bring the temperature about as high as it is possible to get it. In an iron dish melt some tin over a Bunsen burner and carefully pour it into the mold until the electrotype has been covered to a depth of ⅛ of an inch. Turn off the gas under the oven and allow it to cool. When cold remove the molding clay and your electrotype will be ready for use.

Ink the electro and take off a copy on white paper.

The Storage Cell: There is no more important application of the chemical effects of the current than that of the *storage cell.* Of course this cell *does not store up electricity,* as many unthinking people suppose, but chemical energy which can be converted again into electrical energy.

A simple storage cell which will enable you to study at first-hand the chemical action and principle of it may be very easily made. A small battery jar, two lead strips, a battery stand and a 1 to 8 solution of sulfuric acid will be required. First scour the lead strips until they are perfectly bright. Then immerse them in the jar of sulfuric acid mounted on the battery stand and connect to its terminals two bichromate cells. Allow the current to pass for 5 to 10 minutes. Disconnect the charging cells and in place of them insert an electric bell, which you will find rings vigorously. Then remove the lead strips and you will find that the positive one is covered with a chocolate colored deposit. This is lead peroxid. The other plate remains unaffected. Now when these plates are connected in external circuit as they were when ringing the bell, there exist the exact conditions necessary for a simple

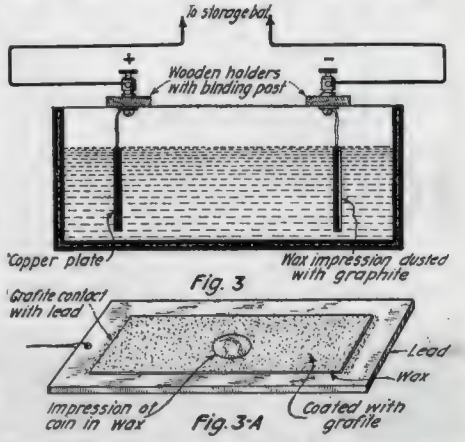


Fig. 3

Fig. 3-A

One of the Most Interesting Electro-Chemical Experiments—that of "Electrotyping." Even the Pages of This Magazine Are Electrotyped.

cell, i. e., two dissimilar substances immersed in an electrolyte that will act on one of them and not on the other, or will act upon the two of them in such a way as to set up a difference of potential. On discharge both plates are changed to lead sulfate and on the charge again back to lead peroxid and lead.

If you wish to make a *real storage cell,* similar to the one shown in Fig. 4, obtain two *lead grids* and a container from a storage battery supply house. Make a stiff paste by mixing together litharge (lead oxid), dilute sulfuric acid and glycerin. With a small spatula or wooden paddle press this paste into the perforations in the two lead grids. Insulate the two plates from each other by placing between them pieces of heavy rubber tubing held firmly in place by large rubber bands at top and bottom. In the container place a 1 to 8 solution of sulfuric acid and immerse in it the prepared plates. To charge the cell a pressure of about 3 volts should be maintained across it for several hours. It would cost but very little to have the cell charged for 24 hours at a charging station. Such a cell will serve for a multitude of laboratory purposes and a number of them will make a very efficient and reliable battery indeed.

Polarization of an Electric Cell: One of the most troublesome features of most cells is their rapid polarization, i. e., the decline of the current owing to the accumulation of bubbles of hydrogen gas on the negative plate. Unless these bubbles are removed they will increase the resist-

(*Continued on page* 424)

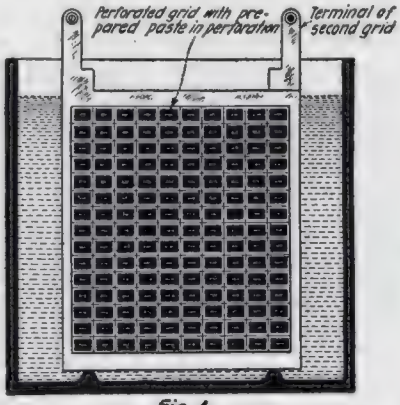


Fig. 4

The Storage Cell Represents the Storage of Electrical Energy in Chemical Form. The Energy Stored Is Really Therefore "Chemical Energy"—But Transforms Into Electrical Energy Upon Discharge.

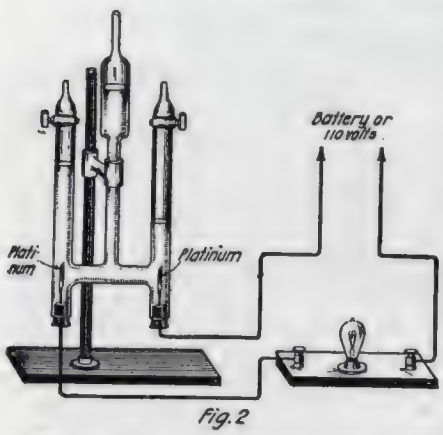


Fig. 2

Electrolysis Apparatus—to Be Used Either with a Half Dozen Cells or on a 110-Volt Circuit (D. C.) with a Lamp in Series.

Electricity from Water Power

By H. Winfield Secor

PART II—(*Conclusion*)

SOME PRACTICAL ASPECTS OF WATER POWER DEVELOPMENT.

How to Compute the Horsepower of Streams and Build Water-Wheels

REFERRING to Fig. 2 several interesting considerations are outlined when it comes to installing water-wheels and turbines (small or large). At Fig. 2-A we see a case met with now and then in actual practise where a water-wheel is sometimes located at a considerable distance from the lake or impounding reservoir dam. In this instance the penstock or flume has to be closed and it may be built square or other shape, of wood, but is preferably composed of riveted steel pipe. At first glance this arrangement looks very odd, but it will be evident that the water will rise without undue loss of pressure to the same height in the gate box over the water-wheel as that in the lake.

This arrangement has the advantage that the penstock can be laid along on the ground or very close to it at small expense while realizing the full head of the water in the lake or impounding reservoir.

At Fig. 2-B the usual method is shown of carrying the water from a lake or reservoir to an overshot water-wheel. Here the penstock, which may be constructed of wood and open at the top, or else of steel pipe, is carried along on wood or concrete piers until the point is reached where the desired head of water is obtained. It will be seen in looking at this figure that we have gained considerable head, even tho the penstock has usually to be carried down to the water-wheel at a slight taper, as the stream would have reached the point X, without having developt any static head outside of its velocity head.

Fig. 2-C shows a plan view of a typical installation of a water turbine. For small, low-head or lower pressure turbines no very elaborate penstock arrangement such as here outlined is used, the turbine being simply set on the bottom of a short flume pit up near the dam. In some cases these turbines operate under a head of but a few feet, especially those of large diameter, and where but a small head is available. This is in contradistinction to the plan of building large dams in order to impound a large quantity of water at a high level or running extra long penstocks in order to carry the water to a point where it could be discharged with a maximum head as is done in many of the wonderful hydro-electric plants in the western part of the United States.

The Accompanying Illustration Shows the Latest Idea in Overshot Water Wheels Which, as Can Be Readily Seen, Is Built of Steel, and Is, Further, Much Superior to the Cumbersome, Heavy-Running Wooden Wheels of the Older Type. As May Be Surmised, These New Steel Water Wheels, no Matter Whether of the Overshot, Breast or Undershot Type, Realize a Much Higher Efficiency Than Ever Was Possible with the Older Wooden Wheel—an Efficiency of 85 Per Cent Being Claimed for the Steel Wheel. The Water Is Brought to the Wheel in a "D"-Shaped Steel Flume.

It is really wonderful to study some of these water power plant developments, and many of us have undoubtedly witnest some of these in the "movies" where one can often see the iron or wooden penstock running along over the hills and valleys for miles like giant snakes. But eventually the engineers' triumph comes to sight and the long winding penstocks finally lead to a precipice or steep embankment, down which they shoot at an angle of possibly 30 to 60 degrees for a distance of anywhere from 100 to 700 feet. The engineers have taken care of the pressure required to force the water thru the horizontal section of the penstock up in the hills by forming a sufficiently large and highly elevated impounding reservoir which feeds the pipe line. But a mighty "pressure head" is developt once the water starts falling thru the angular pipes going down over the hillsides and into the hydroelectric generating station as shown in Fig. 2-D.

In any case it is the best practise to place a good *head gate* or valve near the lake or reservoir where the water passes thru the screens into the penstock and practically all water-wheels and turbines have valves or gates located near or on them in order to cut them into or out of service whenever desired.

Unless the water pressure is very even and the water-wheel very evenly balanced, trouble is frequently experienced in driving electric lighting generators by fluctuations in the speed and consequently in the voltage. There are several electrical methods of overcoming this, but the major portion of these irregularities in speed can be overcome in the prime mover and its interconnecting gearing if a little care is taken.

At Fig. 3 a typical overshot water-wheel electric plant is shown in plan view. To the main shaft of the water-wheel a large master gear is fastened. This may drive one or two pinions as shown, one of these driving a pump or other machinery thru a cut-off clutch, while the other pinion drives a countershaft carrying a second large gear. Meshing with this gear is a second pinion fastened to a countershaft on which a belt pulley is mounted. From here a belt drives the dynamo, and in the best arrangements a second belt pulley on this countershaft drives an automatic fly-ball governor connecting to the water-wheel machinery. Water-wheel companies supply these where necessary or desirable. Usually this automatic governor is geared by means of a chain or otherwise to the controlling mechanism of the gate or valve.

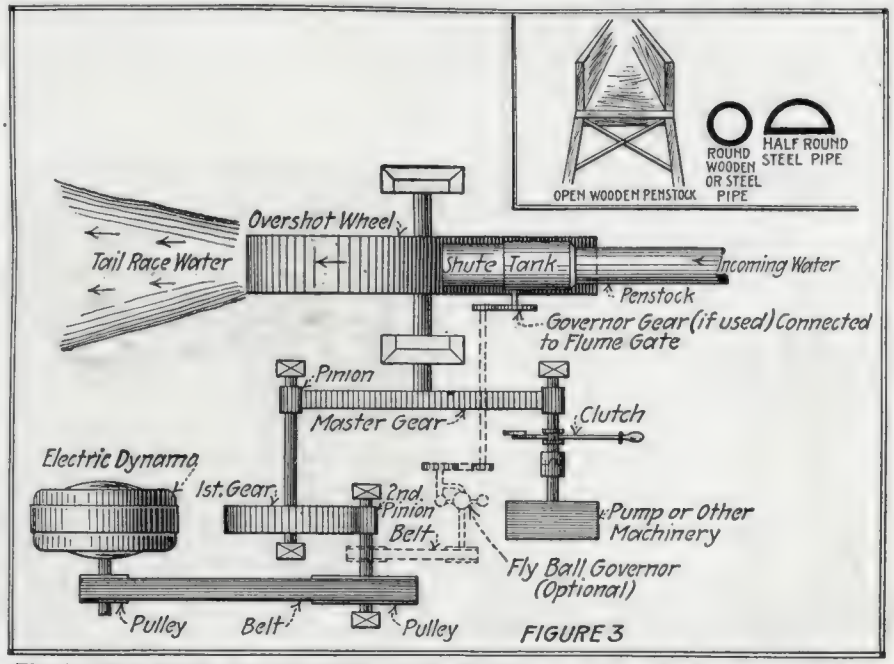


Fig. 3. This Shows How an Automatic Fly-Ball Governor Can Be Belted to the Main Driving Gears of the Water-Wheel so as to Control the Opening in the Flume Gate and Thus Automatically Regulate the Speed of the Water-Wheel in Proportion to the Load. This Is Especially Desirable in Driving Electric Lighting Dynamos.

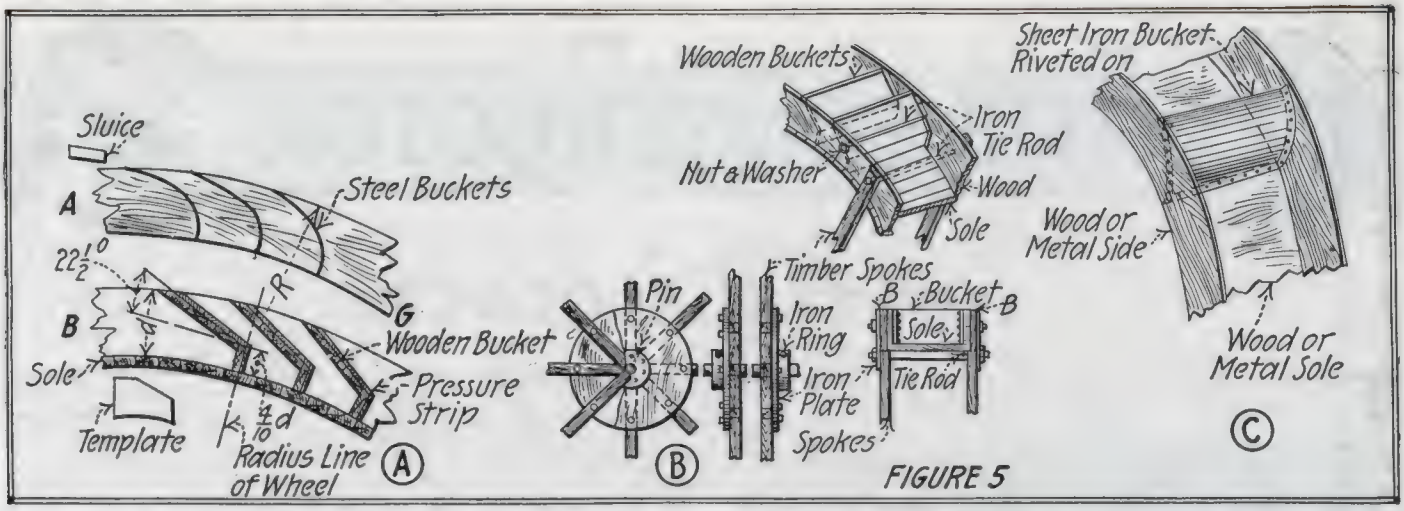


Fig. 5. This Illustration Shows the Various Practical Details Which, Altho Simple, Should Be Very Carefully Watched In Building Home-Made Water-Wheels, as Upon These Factors Will Depend the Tightness and Leakage Factor of the Wheel, the Efficiency With Which the Water Will Leave the Buckets, and Also the Rigidity of the Complete Wheel.

Thus as the wheel speeds up, indicating too much water, the governor automatically changes the size of the gate opening slightly, compensating for the over-speed by reducing the amount of water and vice versa. Many of these water-wheel electric plants develop a sufficiently steady current from the dynamo for lighting purposes, so that no storage battery floating across the line is necessary.

Where the plant, however, causes fluctuation in the voltage and thus flickering in the lights, which cannot be gotten rid of by changes in the driving machinery proper, one of the best solutions is to float a storage battery across the line. Of course where a storage battery is to be used, the dynamo must deliver *direct current.*

While on the subject of water-wheel dynamos, two or three important points should be mentioned. One of these is that for small dynamos, where the rotating member such as an armature and pulley do not have any decided weight, so as to give them a good momentum and thus help to keep the speed steady in driving from a water-wheel, it is very good policy to fit the dynamo with a flywheel type of pulley, such as those supplied on a number of dynamos used in gasoline engine outfits now on the market. The heavy flywheel pulley made of cast iron or steel develops such a momentum or "live inertia" that it absorbs any slight irregularities or pulsations in speed in a well-known manner, and the voltage delivered by the dynamo is in consequence much steadier than otherwise.

In many cases, especially where the dynamo is a small one, say of a fractional horsepower, the voltage employed is frequently 32 or some other value below 110 volts, the standard potential for all lighting service. Owing to the lower losses in the line, such as drop of voltage, etc., and also to the fact that a smaller wire could be used, 110 or 220 volt dynamos are preferable, especially where the current is to be carried over any appreciable distance. Reference to any good wiring hand-book, such as *Cushing's Wiring Manual,* will at once make this clearly evident. Where a low voltage is used, such as 32 volts and higher, there is available on the market today a great variety of electrical apparatus operating on this potential such as electric fans, sad irons, water heaters, curling irons, lamps, toasters, motors, etc.

TYPES OF WATER-WHEELS.

At Fig. 4 there are shown the three principal types of water-wheels, viz.: undershot, breast wheel and overshot wheel. The undershot wheel is frequently used for development of small power such as in brooks, etc., but it is the lowest in efficiency of the three. The breast wheel is employed in some cases where a medium head only is available and the overshot wheel is probably the most efficient of any type now in use. This becomes evident from the fact that practically one-half of the buckets on the overshot wheel are constantly in use, altho not all of them are full of water. In the breast wheel only about one-quarter of the buckets are in use and probably not two-thirds of these efficiently, while in the undershot wheel only about one-eighth to one-tenth the total number of buckets are in use at any time.

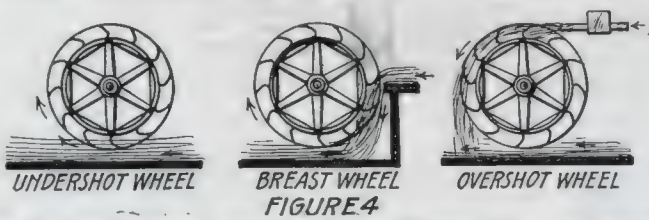


Fig. 4. This Diagram Shows the Three Principal Types of Water-Wheels—the Undershot Type, Breast Wheel, and Overshot Type. The Overshot Wheel Is the Most Efficient, and Should Be Used Wherever Possible.

For the water turbine which is invariably made of steel with two or more sets of vanes, arranged one within the other, very high efficiencies are claimed and elaborate tests have shown them to possess very marked operating conditions under full head of water, but it seems from some other tests made on the latest type of balanced all-steel overshot water-wheels that these wheels can realize an efficiency at full gate, even surpassing that of the turbine, at least on heads up to 100 feet. Moreover, it appears that the overshot water-wheel of the type just mentioned can show a very high efficiency under reduced gate openings, which is not the case with the water turbine. The turbines fall off very rapidly in efficiency and lose about one-half their efficiency in converting the horsepower of the water into mechanical power on the shaft, when the water supply fed to it is reduced to about one-half.

Close-up View of Latest Type Riveted Steel Water-Wheel. The Amateur Water-Wheel Constructor Can Build a Very Effective Wheel from Thin Sheet Iron or Steel by Following the Idea Here Shown, Together With the Instructions Given.

BUILDING YOUR OWN WATER-WHEEL.

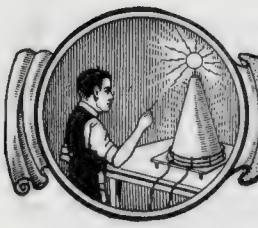
Fig. 5 gives a number of practical details in constructing water-wheels especially of the home-made type. There are roughly two types of wheels which can be built—the wooden and the metal type. A third style might comprise a combination of steel and wood. The shape of the buckets both metal and wood are shown at Fig. 5-A, and the careful design and preparation of these parts spells the difference between low and high efficiency in the production of power by this means. Full details for laying out the proper curves of the buckets were given with all mathematical formulæ in the article by the writer which appeared in the July, 1916, number of this journal and which space forbids repeating here.

At Fig. 5-B several practical hints are outlined for the construction of the spokes, the wooden buckets, as well as the rims. For one thing the buckets should always be very evenly spaced around the wheel and they should also be of similar pitch, otherwise equal quantities of water will not be carried over by the respective buckets causing unbalancing and vibrating of the wheel.

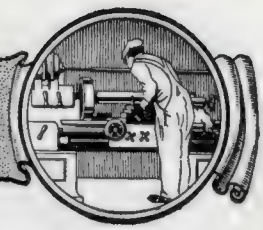
At Fig. 5-C there is shown a steel or sheet iron bucket riveted on to wooden or metal rims and a wooden or metal *sole,* as the inner ring of the wheel is called. For ordinary requirements, especially on small wheels, the shape of the buckets can be approximated from the illustration here given, and in laying out either the wooden or metal buckets time will be saved in making a template of the exact shape of the bucket, which can be laid along the side rims of the wheel and the exact outline of the bucket outlined by pencil or otherwise.

With a little ingenuity the sheet iron buckets can be readily curved by hammer-

(*Continued on page* 430)

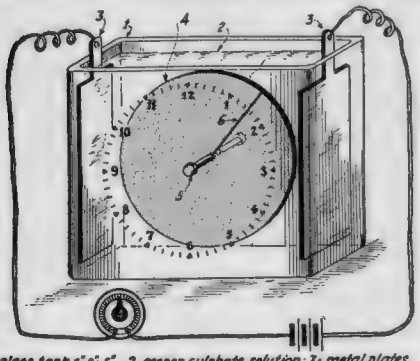


THE CONSTRUCTOR



THE TESLA CLOCK

THERE is always something extremely novel and interesting in the duplication of Dr. Tesla's experiments, but it seems that at times such attempt is rather difficult. However, that may be due to the particular care exercised by Dr. Tesla in having his experiments exact to the minutest point, a feature which amateurs generally glide over. In the case given here, however, there will be no such difficulty in the making of a clock of this nature.



1-glass tank 6"x3"x5". 2-copper sulphate solution. 3-metal plates. 4-balanced copper disc. 5-jewel bearings. 6-glass thread pointer

Dr. Tesla Has Given to the Amateur Construction "Bug," a Simple Idea Which He Used Some Years Ago, In Building an Electric Clock. The Clock Is Simplicity Itself and Comprises a Well-Balanced Copper or Silver Disc, Mounted So as to Rotate In Two Jewel Bearings. Two Metal Electrodes are Placed on Either Side of the Revoluble Disc and When Current Is Applied, the Disc Rotates Very Slowly.

Not only is the clock unique in design, but rather serviceable if a constant E.M.F. is available. It makes an adorable clock for the amateur, even tho it varies slightly from correct time. This, of course, depends entirely on the regulation of the resistance in the controlling circuit.

A clear walled glass jar or celluloid jar is employed, a well balanced metal disc of copper or silver mounted in such a way that it is free to rotate in the centers of two jewelled bearings. These may be obtained from a clock and easily inserted by drilling a hole thru the glass or celluloid jar and securely mounting them therein with a copper washer on each side to prevent any escape of liquid.

On each side and equi-distant from the periphery of this metal disc are placed two metal electrodes similar in nature to the metal *disc*, i. e., either silver or copper. On the disc itself is fastened a thin glass thread pointer or a thin annealed iron wire, the latter being preferred.

The jar now is filled with a solution of silver nitrate if a silver disc has been used, or copper sulfate if a copper disc and copper electrodes have been used. (Electrodes can be copper strips.) If a magnet is now placed in front of the dial so that its action will take place upon the thin annealed iron wire, the disc inside can be rotated to any desired position. Current from several storage cells is now turned on.

The result is that an electrolytic action takes place, metal being deposited on one side of the movable disc while it is taken off on the other side slowly and with remarkable regularity. This causes the disc to rotate slowly, due to a gravitational action, and if carefully regulated a clever timepiece is the result.

The bluish color of the copper sulfate solution makes a very pleasing aspect in a home or library, the experiment itself being one of the least difficult to reproduce. The disc is about three inches in diameter and the electrodes at each end about ½ inch wide and 4 inches long. About three volts E.M.F. will be sufficient if the amperage is quite constant.

According to Dr. Tesla, a slow deposit is more desirable and for this reason a very narrow plate will answer the purpose. If a wider plate should have been used and the disc rotate too rapidly when current is applied to the terminals, the electrodes of both sides may be coated with paraffin so that but a thin space which is cleaned of this paraffin will be effective.

The plate should be slightly wider than the thickness of the disc itself. The disc could likewise be used as one electrode and instead of the two end strips only one would be employed.

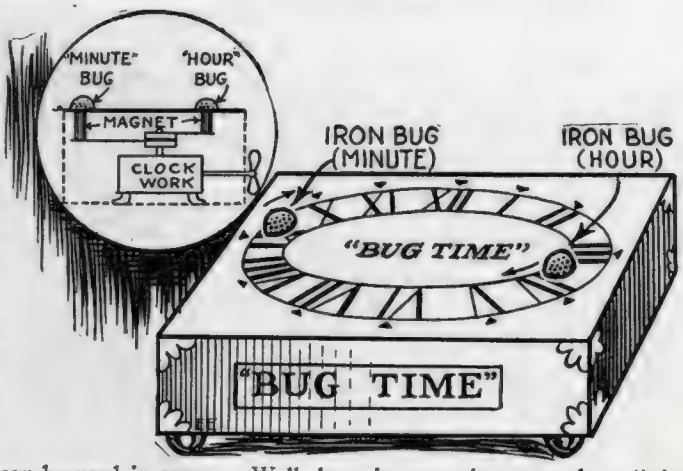
Another essential is that the bearings should be made non-corrosive and at the same time it would be better to lubricate them with a small drop of watch oil. Then when the jar is filled with the electrolyte, the oil will be retained in the bearing zone preventing a deposition of metal upon this zone and corrosion to a great extent.

THIS CLOCK TELLS "BUG" TIME

We recently noted in a jeweller's show window an interesting clock which was labelled with the startling sign, "This Clock Tells 'Bug' Time!" and while the idea involved is almost as old as Methuselah, the action of the device is very novel and pleasing.

No doubt some of our readers have seen similar clocks in their home towns and cities. The clock in question comprises a regular clock work movement mounted in a wooden cabinet, about 12 inches square by 8 inches high. The top of the cabinet was closed by an aluminum dial plate, or this might be brass, or any other non-magnetic metal or material. The clock may be mounted on a sheet of glass suspended on cords or wires well in the foreground, so as to show that no electrical or other form of energy is connected with the clock. Under the aluminum dial plate on the top of the clock the hands of the movement revolve in their usual procession. The hands in this case may have to be made a little stronger than usual, as on the outer end of each there is mounted a small steel magnet. These magnets act on the two iron "bugs" which tell the time. As will be seen from the illustration, the "minute bug" moves around on the outer circle of the dial, while the "hour bug" moves around on the inner circle of the dial. The aluminum of the dial can be as thin as 1/64 of an inch if necessary, but in any case, the thickness of this material will have no more effect on weakening the magnetism than the same thickness of air.

This clock has proven a great attraction in store windows, and can be used in practically every business, such as drug stores, jeweller's stores, etc. The people like to watch the little "minute bug" as he slides along from minute to minute, and besides they—the people, not the bugs—almost forget to eat their lunch in arguing as to how the bugs move over the dial. In five minutes you can hear about 14,000½ explanations of how the bugs tell the time,—including "psychical force"!*?!!



Thomas Reed Used to Tell Us Long and Lustily About His Clocks, — Electrical, Mechanical and Otherwise, But One of the Simplest and Most Novel Clocks Which the Average Electro-Mechanical "Bug" Will Probably Like to Build, Is This Real "Bug Clock" That Tells "Bug Time." As the Detailed Diagram Shows, an Ordinary Clock-Work, One From an Alarm Clock Will Do, Is Used, on the Outer Hands of Which Two Fairly Strong Steel Magnets are Placed. The Two Iron Bugs Can Be Easily Made and Colored.

Well, here is your chance to do a little fooling of your own. Undoubtedly you can find many improvements which will make the action of the "Bug Time" clock more smooth, such as placing little rollers in the miniature iron bugs, etc.

Why the Telephone Howls

By Prof. LINDLEY PYLE

Professor of Physics, Washington University, St. Louis, Mo.

FEW telephone users are unfamiliar with the fact that when the mouthpiece of the transmitter is held against the telephone receiver, in the position usually assumed by the human ear, a piercingly shrill musical note is usually

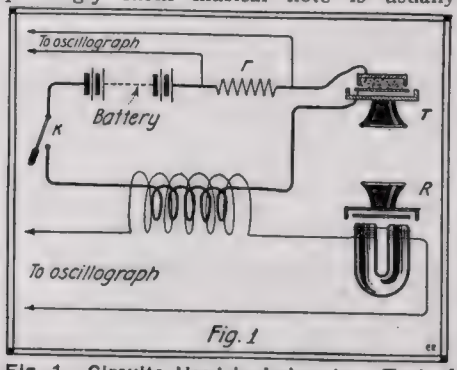


Fig. 1. Circuits Used In Laboratory Test of "Telephonic Howler."

emitted—quick action generally following a slight tap of the receiver against the transmitter.

The phenomenon is easily explained. Fig. 1 shows the essential parts of the telephone system. The transmitter is represented by *T*, the receiver by *R*. Suppose the battery is delivering a current thru the transmitter, the primary of the indicated transformer, and the closed key *k*. Suppose the receiver is on a closed circuit with the secondary of the transformer—no battery included. If the resistance of the carbon contacts in the transmitter be altered by a slight blow against the transmitter case the current in the primary will be altered, which will induce a current flow in the secondary. This induced current sets up a vibration of the receiver diafram which sends an air disturbance over against the transmitter diafram. The resulting

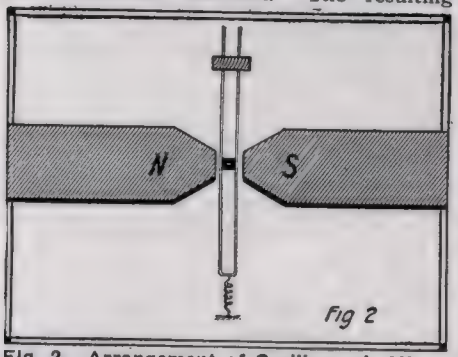


Fig. 2. Arrangement of Oscillograph Mirror Between Two Poles of Powerful Field Magnet. The Mirror is Mounted On the Two Wires Carrying Current from the Test Circuit—These Wires Tend to Twist and Swing the Mirror Beam Over a Scale.

varying pressure on the carbon granules alters the resistance of the transmitter circuit, and the whole sequence of events just described is repeated, the two diaframs maintaining a to-and-fro vibration under their mutual excitation.

The current in the transmitter circuit never changes its direction of flow; it merely strengthens and weakens, or pulsates. The induced current in the receiver circuit is an *alternating* current reversing its direction of flow in accordance with the rising and falling of the current in the primary of the transformer. The writer has used an *oscillograph* to study the way in which these currents vary. The current to be studied is past thru a loop of wire stretched between the poles of a powerful magnet. As the current varies in strength the loop twists to and fro, and a tiny mirror attached to it waves a reflected beam of light to and fro on a photographic film or plate that is moving rapidly at right angles to the direction of motion of the light-spot on the plate. Upon developing the film, or plate, one obtains a wavy line whose shape registers the change in strength of the current in the loop of the oscillograph. See Fig. 2.

Fig. 3 is an oscillogram of the high frequency alternating current in the receiver circuit. A second loop in the oscillograph made it possible to take on the same film a simultaneous record of the current from an alternating dynamo yielding 57 cycles per second. The superposition of these two records makes it clearly evident that the higher frequency in the receiver is 1,270 per second. The current strength in the receiver circuit is zero, as the wave record crosses the middle of the broad straight line running thru the middle of the record.

In order to obtain an oscillogram showing the nature of the current traversing the transmitter, the oscillograph was connected to the terminals of the non-inductive resistance, *r* (Fig. 1). Figure 4 is the interesting record obtained. The striking feature is the wide range of fluctuation in the unidirectional current. Whereas a Weston direct current ammeter in the transmitter circuit registers 0.50 of an ampere, the minimum values of the current (as reckoned from the straight line of zero current) are only eight per cent of the maximum values. The ammeter registers a sort of *average* current. The current falls almost to zero as the diafram of the transmitter swings outward, and then as an air wave pushes it in against the carbon granules the current rises to a value 12½ times larger. Corresponding to the 1,270 cycles per second of the receiver circuit, there are 1,270 pulsations per second in the transmitter circuit. That is, the current in the transmitter rises from its least value to its greatest value in about 1/2500 of a second, and in the next 1/2500 of a second falls to its original small value. To the uninitiated it may appear marvelous that our electrical devices permit us to study what transpires in a few ten-thousandths of a second.

The "howling" will continue even with as much as 80,000 ohms in the receiver circuit. The human body itself may be introduced across a gap in the receiver circuit and the "howling" may be induced without painful physiological results, altho the voltage is considerable. As measured on a sensitive

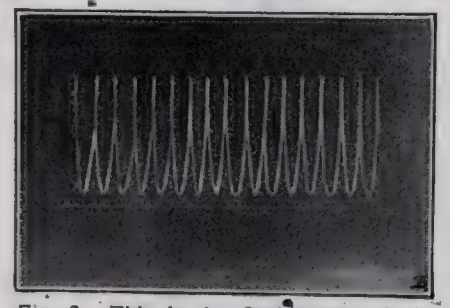


Fig. 3. This Is An Oscillogram of the High Frequency Current in the Telephone Receiver Circuit.

alternating current ammeter the current strength in the receiver circuit, with no resistance other than the receiver and the transformer secondary present, is about 1/200 of an ampere. There are then present 2,000 ohms resistance and considerable inductance.

These results should prove interesting to those who wish to use the device as a generator of high frequency currents where the usual type of sinusoidal current is not necessary.

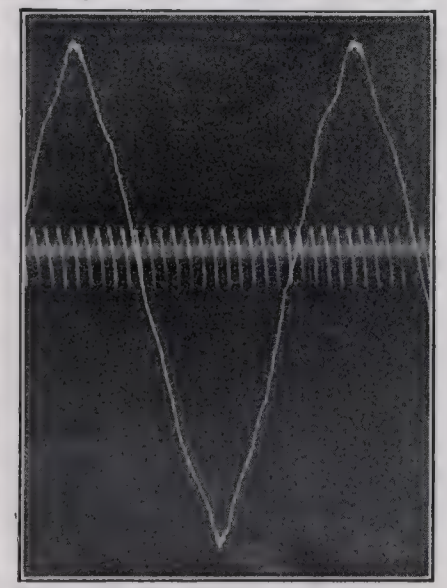


Fig. 4. In This Oscillogram a 57-Cycle, Large Curve, Alternating Current Is Shown Superimposed On the Record of the Telephone Receiver Current, Demonstrating That the Latter Has a Frequency of 1,270 Cycles Per Second.

Trees Make Good Batteries

While reading the editorial in the June ELECTRICAL EXPERIMENTER on "Tree Wireless", the thought came to me: Why not use trees for batteries, as they probably have electrical currents in them the same as the human body? So, acting under this impression, I proceeded to make experiments which would possibly prove my suspicions correct.

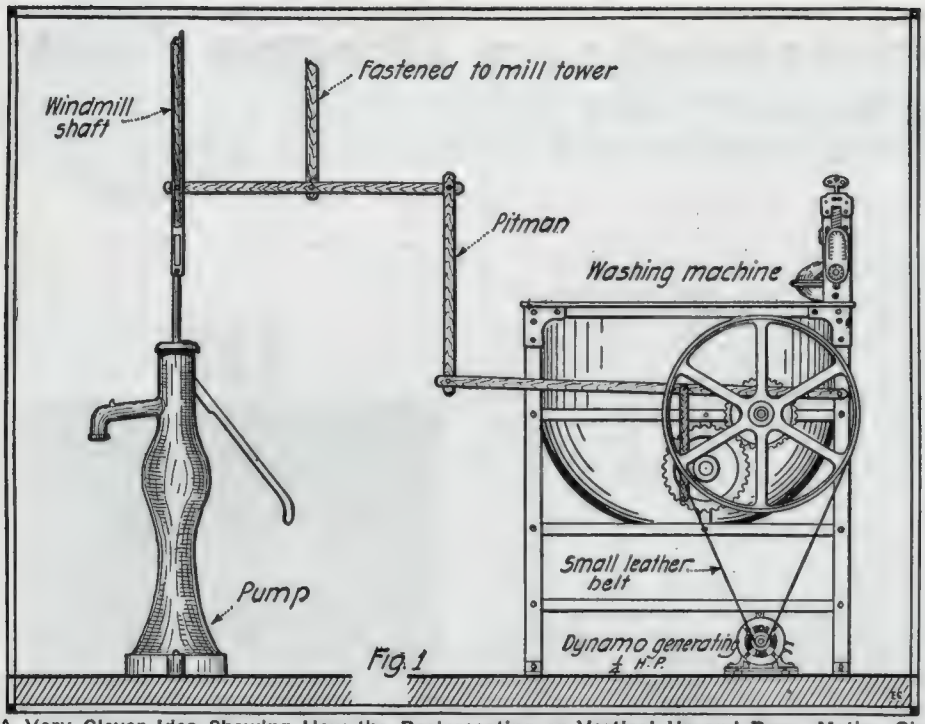
I found by driving a nail in the trunk of a tree four or five feet above the ground (however, this makes no difference as to height), and placing a rod in the ground for the other pole, I could get a comparatively strong current.

I first connected my wireless receivers in series with the nail and ground rod, and finding the current so strong, I tried placing a transmitter in the circuit. I found I could hear sounds surprisingly well, the transmitter working as well as if it had the customary dry cells. I then tried placing an induction coil in the circuit, but this seemed to decrease rather than increase the sound, the best results being attained by utilizing the transmitter and receivers in series with the nail in the tree and the ground rod. I also found that carbon block microphones worked extremely well with this source of current, proving very sensitive.

A galena detector placed in series with the "tree cell" and the phones is extremely sensitive to jars.

If a tree is used which has a large decayed cavity in the trunk the current is made much stronger by placing the ground rod in this.

Contributed by ORAN McILVAINE.



A Very Clever Idea Showing How the Reciprocating or Vertical Up-and-Down Motion Obtained from a Windmill Could Be Converted Into Continuous Rotary Motion for Driving a Small Dynamo. An Old Washing Machine Gear-Motion Does the Trick.

Windmill Pump Runs Dynamo

A farmer lad, with a general liking for things mechanical and more or less of an experimenter and inventor, rigged his mother's old washing machine to the windmill in a novel way to run his small electric generator. The dynamo required a bit more power to run at top speed than the lad cared to exert for any length of time thru his home-made device.

So on a temporary platform next to the pump the washing machine, of the type shown, was moved and the handle connected to the mill shaft by an upright pitman and the rocker cross-arm long enough to reach across the intervening space.

The dynamo was fastened to the platform with lag screws, just under the flywheel of the washing machine, and belted to the same with a small flat leather belt. The original wheel on the dynamo was too small for the purpose and another of the right size to produce the best results at the average speed of the windmill, put on in its place.

When this was connected up, the pump was disconnected, and the mill allowed to run for several hours at a time. The electricity thus generated charged a storage battery, consisting of several cells, located in the shop nearby, and furnished a constant and dependable current of electricity.

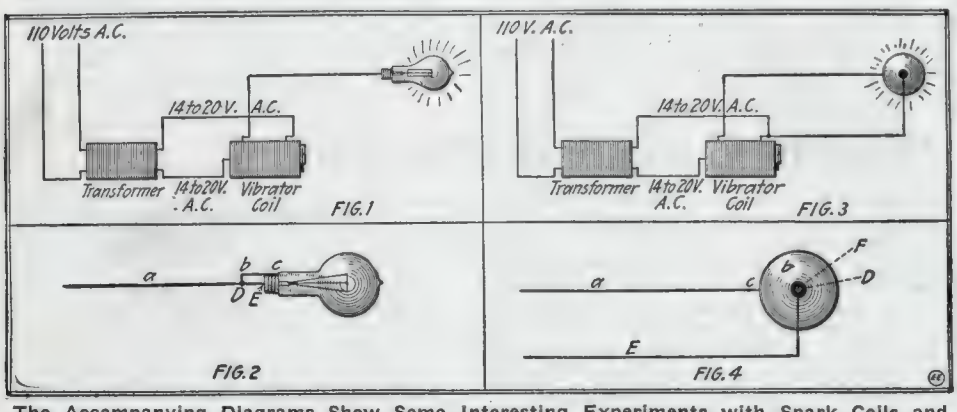
Contributed by DALE R. VAN HORN.

Spark Coil Experiments

Herewith are instructions for making Experiment No. 1. Procure a 110-volt reducing transformer which will step down the current to about 14 volts to operate a spark coil. An old ignition coil from a Ford car will do. Connect it up to the transformer as shown in drawing. Now get a piece of heavily insulated wire, reinforced cord will do, and connect this to the coil as per drawing. If Ford coil is used, binding posts must be soldered to contacts and then turning to Fig. 2 solder wire C to A at D, then solder wire C to the base of a 75 or 100 watt lamp (which is burnt out) at C. Next solder wire A to base of lamp at E. Tape well and when the current is turned on you have a Violet-Ray outfit.

Directions for Experiment No. 2:—The transformer and spark coil are the same as in Experiment No. 1. Just a word about Fig. 2. B is a flashlight reflector and F is a burnt out flashlight bulb. The wire A is soldered to reflector B at C. The wire E is soldered to back of bulb F at D. When the current is turned on, the bulb will light up with a purple light.

Contributed by C. S. WEBB, JR.



The Accompanying Diagrams Show Some Interesting Experiments with Spark Coils and Burned-Out Incandescent Bulbs, All of Which Are To Be Found in Every Experimenter's Laboratory.

POCKET SHOCKING COIL.

A screw-cap shaving stick tin is cut thru the middle, the halves separated ½" as shown at A, Fig. 1, and the gap is bridged by a 1" length of fibre tube that fits tightly over the two halves of the tin. These two portions, insulated from each other, form the *handles* for taking the shock.

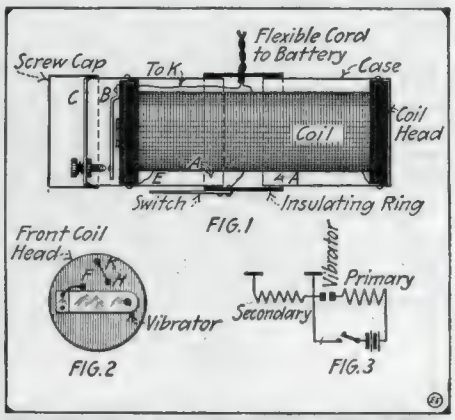
The coil heads are ¼" thick hard wood, paraffin waxt, and make a snug fit inside the tin. A ⅜" hole is bored thru the center of each for the core and the front head has holes made and the vibrator fixt on as shown in Fig. 3. The other coil head requires a small hole for the start of the secondary to pass out thru.

The vibrator is a 1¼" length of spring from an alarm clock with a silver contact soldered or riveted on as shown. Bend a ⅜" x ⅝" piece of sheet iron over the vibrator for the core to pull on. Hammer it tight so it does not shift.

The core is formed of a bundle of soft iron wires 3" long and ⅜" in diameter. The space between the coil heads is 2 7/16".

After fitting the heads tightly on the core, wrap three or four layers of shellacked brown paper around it and wind on the two layers of No. 24 S. C. C. wire for the primary coil. The start of the primary winding is brought thru hole F, Fig. 2, and fixt to the vibrator; the end of the winding is taken thru hole H and then back thru K.

Over the primary wind three layers of shellacked paper and then put on the secondary which consists of eleven layers of No. 36 enameled wire, covering this again with a further wrapping of shellacked paper.



This Shocking Coil, Built Into a Metal Shaving Stick Container, Will Afford Lots of Fun for You and Your Friends. You Will See the Point More Quickly Than They, However! The Two Handles Are Formed by Dividing the Metal Case Into Two Pieces, by Means of a Fiber Ring or Sleeve.

Next bore a hole thru the fibre ring for the flexible cord from the battery and rivet a piece of springy brass strip about ¼" wide and 1¼" long diametrically opposite this hole, fixing one wire of the flexible cord thereto. This strip acts as a push button and controls the battery current.

Twist the bared ends of the secondary winding over the coil head at each end so that they will make contact with each half of the container when in position. Smear some cement (a kind that will stick glass or iron) on the inside surface of the fibre ring and push in the ends of the container leaving about half an inch space between them.

Finally solder inside the tin the stiff brass strip, C, which acts as a contact pillar, having previously attached a nut for the screw to work in as shown. A fairly stiff spiral spring made of brass wire and placed under the screw head will prevent it slacking back when in use and is more convenient than a lock nut.

To make it real "hot" wind on more layers of finer wire or use more battery voltage.

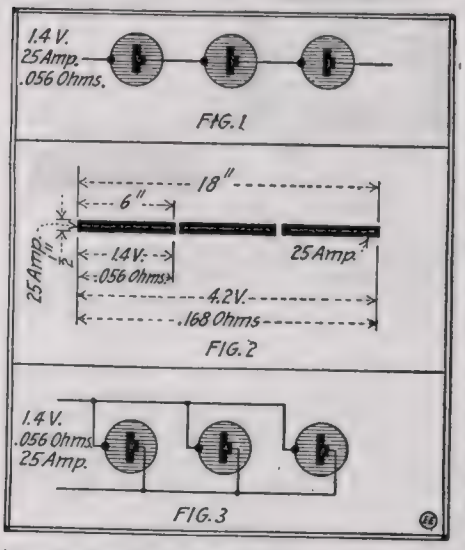
Contributed by K. McLEAN.

A Simple Explanation of Ohm's Law

By W. F. PERRY

In Regard to Series, Parallel and Series, Parallel Battery Connections

In explaining the differences (in voltage and current output as well as the difference in internal resistance of cells connected in any of the above named combinations) to my classes, I make use of three or four small sticks each six inches in length and one inch square.



One of the Best Ideas We Have Seen In Some Time Is That Suggested by Mr. Perry, Who in His Class-Room Work, Makes Use of Small Wooden Sticks, Each of Which Illustrates One Unit of a Battery, With a Given Voltage, Resistance and Current Available. By Placing the Sticks in Various Formations, the Relations in Different Battery Hook-Ups Are Evident at a Glance.

Naturally, I first consider the *Series* connection, and draw a simple sketch of three cells thus connected, giving the data pertaining to one of the cells, (assuming that the others have the same characteristics).

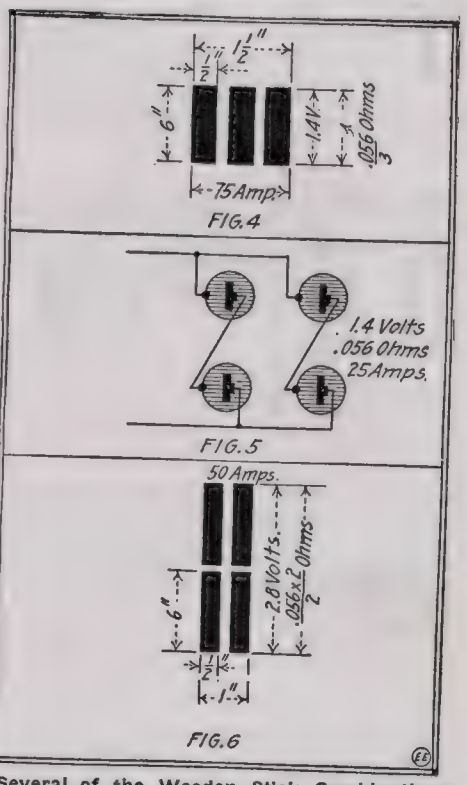
Having made the sketch and given the data I asked the question—What is the total voltage and current output of these three cells? Of course there appears to be some uncertainty on the part of the boys, as can well be expected when they really do not know—but such a question as this is perfectly proper because it causes the boys to think, and thinking is good for them. I now produce the three sticks and give them the dimensions of one of them. By placing the sticks end to end, I ask "What is the entire length of these three sticks?" Everybody answers, because everybody knows. "What is the width of this long stick." Exactly the same width as one stick of course. Having thus got the boys interested, it is a very simple matter to explain to them that the length of one stick will demonstrate the voltage of the single cell and also the internal resistance, while the ampere or current output is represented by the width; having thus related these things, the sticks are placed end to end, and thinking in the terms of volts, current and resistance, the boys thus can easily figure out the output of three series connected cells. Now that the boys can very well figure out what the output of any number of these cells may be, we move on to the next step—*Parallel* Connection.

The connecting lines in Fig. 1 are erased and lines drawn which represent the three cells as connected in *parallel*, the same data being used. To represent this connection the three sticks are placed side by side. It will be seen that the length of the sticks remains the same as one stick—that the width increases three times and that the resistance remains as the length of a single stick, therefore the voltage output of a parallel combination is the same as any of the single cells; that the current output is three times as great and by formula the internal resistance is the resistance of one cell divided by the number of cells.

Several lessons are given to examples or problems of this type and when it has been thoroly mastered the third and last type is given attention.

The sketch 5, the *series-parallel* combination is placed on the board as above and the same data applied. The boys then take a few moments for consideration of the problem after which they are asked what their opinions of the total output are. The answers are often surprising and the great majority, much out of the way. The sticks again come into play at this point—there being four of them instead of three, as in Fig. 6.

By relating the lengths and widths of the sticks with the voltage-current and internal resistance, the solution of the problem is very simple. The total length is twice that of one of the sticks—the total width is twice that of one of the sticks—therefore the total voltage output is twice that of one cell—the total current output becomes twice that of one cell, while the total internal resistance of the combination becomes by formula



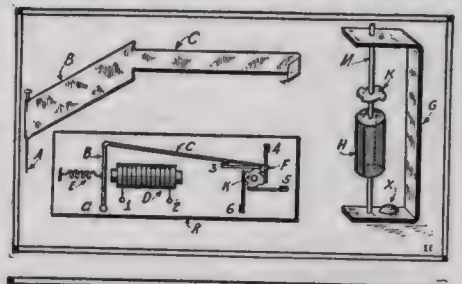
Several of the Wooden Stick Combinations Used by Mr. Perry to Teach His Students "Ohm's Law" in Connection With Battery Circuits, are Here Illustrated. This Idea Could Be Used Very Nicely for "Home Study" as Well.

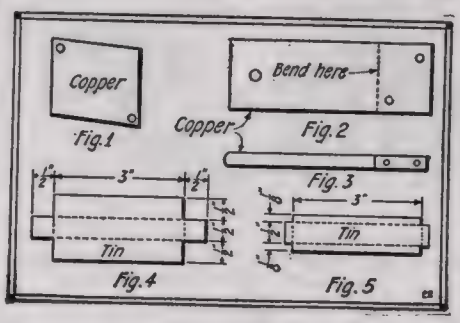
$R = \frac{r\,n}{n_1}$; where R = Unknown Resistance, r = resistance of one cell, n = number of cells in series and n_1 = the number of cells or groups of cells in parallel. It may be that this is an old method with some of your readers—if not, and you have ever the opportunity to teach any one the methods of calculating outputs and resistances of combinations of cells—just try it.

A Cheap Relay Reverser

The following is a description of a relay reverser that will work on A.C. or D.C. Referring to the diagrams, base R should be a block of wood 2" x 3" x ½". Armature B, arm C, and catch F, are all one piece, cut from soft tin and bent as shown,

This Simply Made "Relay Reverser" Will Appeal to All Experimenters and Particularly to Those Working Out Problems in Miniature Electrical Railway Train Control. The Reverser May Be Placed in the Engine or Coal Car, So That the Train Can Be Stopt and Reversed By Closing, Opening, and Closing Again,—Quickly,—the Main Supply Switch. Each Impluse Turns the Switch Drum a Quarter of a Turn.





with the free end of B bent around nail A, which is driven into the base R. The ratchet wheel K, which is cut from tin, should be ½" in dia., and soldered to axle M. Below K is a two-section commutator H, also secured on axle M. The tin piece G, bent as shown and fastened to the base by screw X, which serves to hold M vertically. The brushes 3, 4, 5 and 6 all bear at right angles upon H. D is a low resistance electro-magnet which attracts B. Thus when posts 1 and 2 are connected to a circuit, D attracts B which moves arm C and catch F. When the circuit to D is opened, the spring E pulls back B and F turns H one-fourth of a revolution.

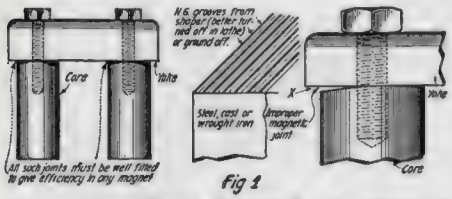
To control the direction of an electric train place the relay reverser in the engine or coal car. Connect post 2 with brush 3. Then remove the wires that run to the brushes of the motor and connect one to post 1, and the other to brush 5. Next connect the motor brushes to brushes 4 and 6. To stop the train and then make it continue in the same direction, the supply switch must be quickly closed, opened, and then closed again. To control lights from a great number of places, and thus be rid of forty-'leven-way complications, connect a small battery to D, using push buttons to close the circuit and brushes 5 and 6 in series with the lights. The brushes make no connection whatsoever with the ratchet-wheel. **Contributed by PAUL R. GROVE**

The Electrical Machinist

By H. WINFIELD SECOR

NO. 10—POINTERS ON IRON MAGNETIC CIRCUITS.

THE electrical machinist naturally meets with many problems in his daily work concerned with the building and repair of dynamos, motors, electric lifting magnets and various other magnetic or electro-magnetic mechanisms. The writer has thought that some pointers on the accuracy and general arrangement and construction of magnetic parts, such as the cores and yokes of dynamos, motors, etc., would be welcome.



All Iron Core Faces Should Be Machined or Filed Perfectly Smooth to Prevent Undue Magnetic Loss at Such Joints.

Referring to Fig. 1, we see one of the simplest cases met with in electrical machine shop work, that comprising the alinement of two magnet cores with their connecting yoke. On small dynamos such as fractional horse-power machines, etc., it does not matter so much as on larger machines, in some ways, as to whether or not the ends of the cores are very finely smoothed off, as well as the abutting surface on the yoke. Strictly speaking, however, on the small machine the magnetic losses are comparatively greater for a given size of air gap or space between the abutting surface.

On all good commercial makes of dynamos and motors, however, the abutting surfaces of cores and yokes, pole-pieces, pole-shoes, etc., are very accurately fitted, as even a 1/64th" air gap will mean a considerable loss in the magnetic power of the circuit owing to the extra magnetizing energy required in the coils to force the full quota of flux lines across the air gap. Probably this can be better realized when it is known that for a given size of iron core, say at the point "X" (see Fig. 1) where the core abutts the yoke member, that for a one inch length of the iron only 31.2 ampere-turns are required in the magnetizing field coil, let us say. For the same dimension core and if perchance, the core did not abutt tightly and make a perfect fit against the iron yoke member, but left a 1/64th inch *air gap* between them, then the ampere-turns required to force the flux called for in the design of the machine across this air gap would be 12.5 times that required for one inch length of iron core, or 370 ampere-turns. For a one inch air gap, 800 times as great a magnetizing force in A. T. would be required. In the case cited, for forcing 80,000 lines thru annealed wrought iron, 31.2 A. T. are required per inch of length of iron core. For one inch of air core or gap, 24,960 A. T. would be necessitated.

That is, a greater amount of ampere-turns or magnetizing energy is required in the coil to force the total magnetic flux across an air gap as short as 1/16th", as is required to force the total magnetic flux thru the whole iron magnet frame. In assembling the cast or wrought iron, or cast steel, cores and yokes of magnet frames, steel machine screws or bolts are invariably used, and never brass ones, of course, except under special conditions to be described in connection with Fig. 2.

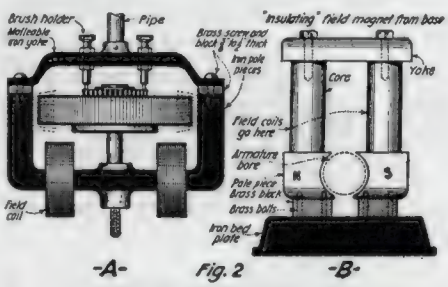
Referring once more to Fig. 1, it is often found in practise on dissembling a dynamo or other magnet frame that the abutting surfaces of the magnet members have been finisht off on a *shaper,* leaving a fine series of tool lines or grooves across the surface which is intended or at least, was intended by the designer to form a *perfect magnetic juncture* with the abutting surface. Of course such a rough finish as this is improper and it is much better, when permissible, to mount the part in the lathe and turn it down with a round nosed tool so as to be as smooth as possible, and finally finish it off with a fine file or a good square block and some very fine emery paper. Or again, the surface to be finally finisht may be very smoothly milled down in a milling machine or vertical boring mill, using a radial milling cutter of the finishing type. Where small magnet members are to be closely fitted and no machine is available, they can be filed very carefully, finishing with a fine single cut file and testing the flatness and squareness of the surface with a small steel square from time to time.

HOW TO "INSULATE" MAGNET FRAMES.

Taking up the diagrams at Fig. 2-A and B, we see two interesting cases where the auxiliary iron members of motors and dynamos had to be *insulated,* in the parlance of the electrical machinist. Of course, as we well know, there is no insulator of magnetism and the only way to prevent the magnetic flux from shunting around the auxiliary iron bars or brackets which may happen to abutt salient field poles, is to space these members away from the active poles by means of brass, fiber, zinc or gun metal blocks in the manner shown, both at Figs. 2-A and B.

In the case illustrated at Fig. 2-A, this was a fan motor of which many thousands were built in a shop, with which the writer was connected at one time. The field frame was ingeniously molded of cast iron with four pole-pieces, but only two are shown here, for simplicity. The field coils were wound on forms, taped and slipt over the pole-pieces, then thoroly shellacked and painted; finally, with a little pounding into shape with a wooden mallet, they formed themselves so as to hold tightly in place on the field cores, in the position shown.

The armature was of the ring type and rotated vertically, the ceiling fan blades being screwed on to the bottom of the threaded shaft. The iron supporting yoke, which carried the ceiling support pipe or tube, also carried the insulated brush holders. It will be noted that under each foot of the malleable iron supporting yoke there is placed a one-half inch brass block, of the same shape as the pole-piece, and measuring about two inches by three quarters of an inch, mean dimensions. A 3/8" brass machine screw, having 16 threads to the inch, was threaded 1½" into the pole-pieces on either side, as shown. These were tightened up with a large screw driver formed by grinding the end of a large discarded file to the proper shape, so that with the aid of a monkey wrench, these screws could be tightened up with plenty of pressure, as if they ever vibrated loose, the field frame might drop and kill someone. To prevent the brass blocks from turning, they were pinned with a brass pin on one side of the machine screw.



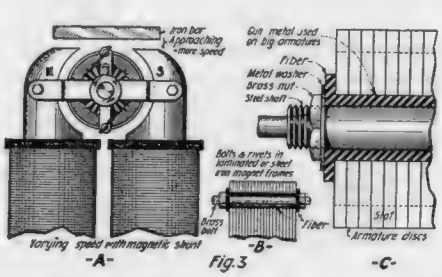
Showing How Zinc or Brass Blocks Are Placed Between Iron Magnet Frames and Bases, Etc., to Prevent "Shunting" the Magnetic Flux.

The theory of this arrangement is that the active field flux or the major portion of it, will pass into the armature coils and thru the armature core, and that very little of it will leak up and thru the brass blocks, and thus shunt around thru the iron yoke. Of course, a brass support yoke would have been a very good idea here, and in fact at one time brass yokes were used, but this material became so expensive, and for several other reasons, that it was finally discarded and the malleable iron yoke adopted as the standard.

These fan motors are still being built in large quantities, and the motor is rated at about one-eighth horse-power.

Referring to Fig. 2-B, we here come into the realm of both large and small dynamos and motors, many of which type are still in use now. Primarily, this is the old Edison type of dynamo and the electrical machinist will run into many machines of this type on repair jobs, but very few, if any of this form, are being built today, owing to the large magnetic leakage inherent in this design.

In these machines, even in such large sizes as several hundred horse-power, where the pole-pieces are on the base, then it has been necessary to place large zinc or brass blocks under the pole-pieces and between the latter and the base plate, for the purpose of preventing the shunting of a goodly part of the field magnet flux thru the iron base. The writer remembers one of these machines rated at about 100 K.W. where the zinc blocks were 3½" thick and about 8 by 10 inches in size. Of course on small machines, the measurements of the blocks are less in proportion. In some machines of this larger type, the builders have taken a chance and have used steel bolts, but it is apparent that brass screws should be used to fasten the poles to the base frame.



Controlling Speed of Motor by Magnetic Shunt and "Insulating" Tie Rods and Shafts of Laminated Iron Magnet Frames.

(*Continued on page* 439)

HOW-TO-MAKE-IT

This department will award the following monthly prizes: First prize, $5.00; Second Prize, $3.00; Third Prize, $2.00.
The purpose of this department is to stimulate experimenters toward accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $5.00 is awarded; for the second best idea a $3.00 prize, and for the third best a prize of $2.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

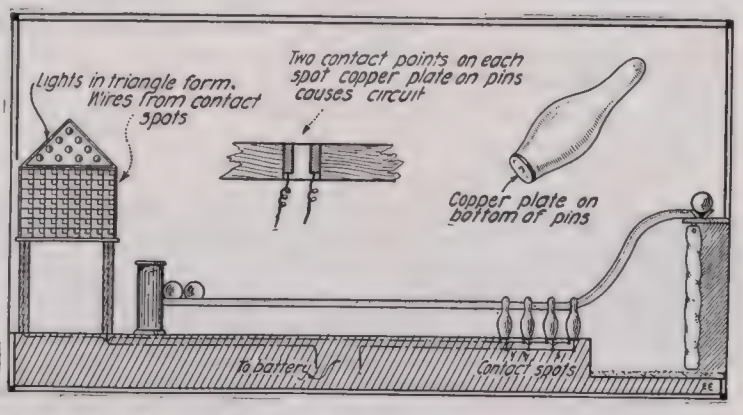
Electric Bowling Alley Signal

FIRST PRIZE, $5.00

Herewith find drawing of an electric bowling alley; my idea is to fasten small copper plates to the bottoms of the wooden pins as shown. And having two contact points to each spot, so when the pin is set on the spot the copper plate will close a circuit, lighting up the corresponding light; all the lamps being attached to a board in triangle form so as to duplicate the way in which the pins are set up. Should two of the ten pins not be directly on the spot the bowler will know instantly, as two of the ten lights on the triangle will be out. The bowler can then tell the careless pin setter just what pins are not on the spot which otherwise he could not do; as it is not a very easy matter to see whether all the pins are directly on the spots or not. The triangle with the ten lights set up on a board right where the bowler can easily see them.

An Ingenious Idea for Making an Electric Bowling Alley Signal, Which Can Be Used in the Home Alley.

Contributed by T. SHEEHAN.


Lights in triangle form. Wires from contact spots
Two contact points on each spot copper plate on pins causes circuit
Copper plate on bottom of pins
To battery
Contact spots

Dynamo Bicycle Light

SECOND PRIZE, $3.00

I herewith submit to you a diagram of a "Dynamo Bicycle Light." It is easily constructed for a few dollars; any old battery case will do, providing it is large enough to accommodate a small dynamo, besides extra battery.

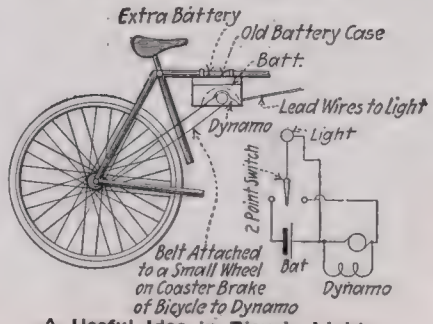
A small wheel is fastened by bolts on to the hub of the rear wheel between the two bars, and a small leather belt runs from this wheel to a small 4 to 6 volt dynamo.

The dynamo should furnish about four to six volts. A small switch is attached on the case to control the current by either battery power or dynamo; the battery comes in handy when pedaling up a hill and the wheel does not go fast.

The current then flows thru the lead wires to your light.

Therefore, I claim that this mode of lighting bicycle lamps is very efficient because it saves its owner a large sum of money that he would spend for batteries.

Contributed by FRANCIS LIEGLER.



A Useful Idea in Bicycle Lights.

Electric Heaters—Build Your Own

THIRD PRIZE, $2.00

I am sending you a drawing of an electric heater that I have tried out by experiment to heat an ordinary-sized room, and it will do it! It comprises an old coffee can, square preferably, a socket, an insulator or lead in tube, an attachment plug, cord, a nitrogen bulb, and a stand which can be cut out of sheet iron or tin. See Fig. 1. To make one of those new-fangled reflector heaters (see Fig. 2), procure a bright tin wash basin at the ten-cent store. A good size headlight reflector, or else a hammered copper reflector, will serve the purpose admirably. Next we need the heating coil. Old fan speed regulator resistance coils are useful, after you have cut out some of the wire to find out just how much will be needed to become red hot when connected to the line. A porcelain tube is imperative, and it can be wound with several yards of some resistance wire, such as No. 24 to 26 "Climax," German silver, Driver-Harris No. 193 alloy, and especially "Calido," a very good wire which will not oxidize even with a temperature in air of 2,000 degrees Fahrenheit.

Contributed by RAYMOND MATCHUN.

Home-made Electric Heaters Are One of the Simplest Devices to Make, But They Must Be Built Right If They Are to Be Satisfactory, and Especially Fire-proof. These Heating Devices Get Pretty Hot and They Should Always Be So Designed as to Be Rigidly Supported Away from All Combustible Materials. Electric Lamp Heaters Have Been Adopted in Many Instances, and for Those Who Prefer This Form of Heater There Are Special Forms of Frosted "Heater" Lamps for Radiant Heaters Available on the Market.

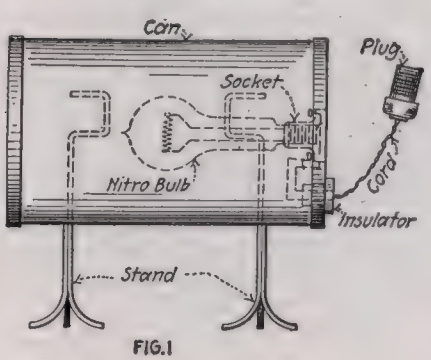


FIG. 1

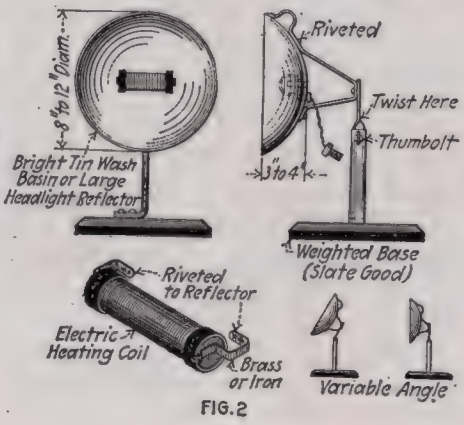
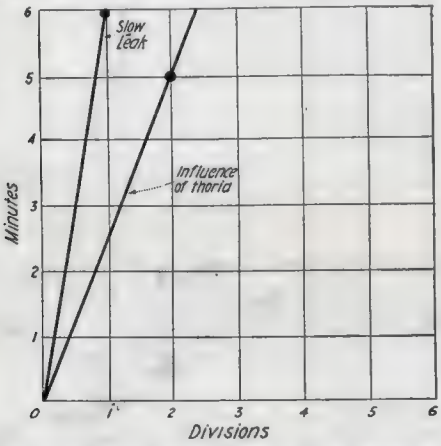


FIG. 2

SIMPLE EXPERIMENTS WITH AN ELECTROSCOPE AND THORIUM.

Many experimenters in radio activity find it hard to buy material for experiments in this interesting branch of science. Below are some experiments with substances which are cheap and found in every laboratory.

Obtain a new gas mantle from your dealer, or a broken one from home. This



Simple Graphic Chart, Showing the Decreased Time Required for Discharging a Gold-leaf Electroscope, When Some Radio-active Substance Such as Thorium is Brought Into Proximity to the Charged Members.

mantle is made up of ninety-nine per cent thoria, oxid of thorium, and one per cent ceria, oxid of cerium. Grind the mantle into a powder.

Calculate the slow leak of your electroscope by timing its fall over two or three divisions. Place some thoria on a piece of paper under your electroscope. Now, notice how long it takes the gold leaf to fall two or three divisions. A very interesting graph of this experiment may be made as follows: Suppose the slow leak of the electroscope is one division in six minutes. Place this on the graph. Now under the influence of thoria's ionizing power, suppose it falls two divisions in five minutes. Place this on the graph and a very neat comparison may be made between the slow leak with and without thoria.

Thoria is decomposed easily by treating it with sulfuric acid. Thorium sulfate cannot be obtained from this solution because the sulfate is very deliquescent. However, we may obtain the white hydroxid of thorium, $Th(HO)_4$ by evaporating nearly all the acid, diluting with water and adding ammonium sulfid. This hydroxid is insoluble in excess of the reagent.

Filter the hydroxid and dry the residue on the filter paper. Then test its radio-activity and chart your results as you did for thoria.

Now precipitate thorium carbonat from the thorium sulfate solution, by adding sodium or ammonium carbonat. This is soluble in excess but is precipitated on heating and allowing to stand. Filter this solution and dry the residue on filter paper. Then test and chart the radio-activity as before.

These three charts may be compared and if the experiments were conducted carefully, they will be almost in the same ratio.

Contributed by R. K. INNES.

MULTIPLYING FEET AND INCHES.

Contributed by Dr. W. A. Ballou, Pratt Institute, Dept. of Mathematics.

You were doubtless told by your school teachers that it could not be done. However, the only thing that is necessary is the use of a third unit of square measure that we shall call a strip. A strip is an area 1″ × 12″, and so contains 12 square inches or one-twelfth of a square foot.

3 ft. 6 in.
8 ft. 4 in.

sq. ft.	str.	sq. in.
24	48	24
	12	
24	60	24

That is, 3 ft. × 8 ft. = 24 sq. ft.; 8 ft. × 6 in. = 48 strips; 3 ft. × 4 in. = 12 strips; and 6 in. × 4 in. = 24 sq. in. But 12 strips make one square foot, so 60 strips will make 5 square feet to be added to the 24 square feet, making 3 ft. 6 in. × 8 ft. 4 in. = 29 sq. ft. 24 sq. in.

We shall now consider an example in which the number of strips is not an even multiple of 12.

2 ft. 5 in.
8 ft. 2 in.

sq. ft.	str.	sq. in.
16	40	10
	4	
16	44	10

In this case the 44 strips are divided by 12, as before, giving 3 square feet to be added to the 16 square feet. The remaining 8 strips are multiplied by 12, thus reducing them to square inches. The 96 square inches so obtained are added to the 10 square inches making 106 square inches in all. 2 ft. 5 in. × 8 ft. 2 in. = 19 sq. ft. 106 sq. in.

After a little practise by this method, feet and inches may be multiplied mentally. For example, the area of a table top 3′ 4″ × 5′ 10″ = 19 sq. ft. 64 sq. in.

CHEMICAL ORNAMENT.

Put three inches of sand in the bottom of a vessel such as a small glass globe, and on the sand place some pieces of the copper, aluminum and iron sulfates. Over this pour a solution of one part sodium silicate to three parts water. Let it remain quiet for 7 to 10 days, after which a dense growth of the silicates will have taken place, in many colors. Then place a rubber tube in the globe and let a stream of clear water pass thru the solution until all the cloudiness has been cleared away.

Fire from Water: Put a small piece of metal potassium in cold water and it catches fire, it darts about and splutters and when near an end it explodes with a sharp detonation. In a dark room trace with a camel's-hair brush your name, with water, trace this on paper and put the paper on a piece of tin, then place a piece of the potassium on the wet line and it will write the name.

A little piece of phosphuret of lime placed in water produces effects somewhat the same as the above. It takes fire snappishly, and rises in gas bubbles to surface, exploding on contact with the air and ascending in wreaths of smoke.

Saturate a lump of sugar with phosphorized ether, and placing it in warm water it will become luminous in a darkened room, and by blowing upon it brilliant and beautiful waves of light will be seen.

Fire under Water: In a small tumbler of water, at 140 degrees, drop two pieces of phosphorus about the size of peas. Then take a bladder containing oxygen, to which is attached a long thin tube, with a stop-cock. Press the bladder gently and as the gas reaches the phosphorus will take fire, filling the glass with brilliant flashes of light darting here and there in the water.

Silver Tree: Place a soft amalgam of silver into six parts of a solution of nitrate of silver, and four parts of a solution of nitrate of mercury. A beautiful precipitation in a tree-like form is the result.

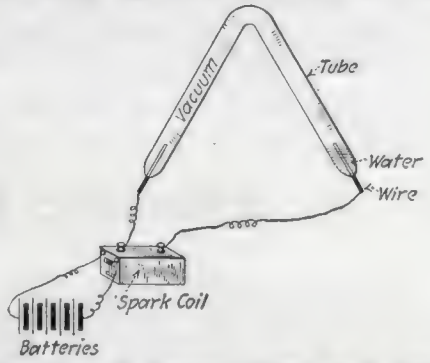
Contributed by EXWYZED.

HOME-MADE GEISSLER TUBES.

Owing to the war, the price of Geissler tubes has advanced beyond the means of most amateurs and the following device is a simple substitute for the same.

A copper wire—or, much better, platinum—is fused in one end of a glass tube which has been bent as shown in illustration and whose dimensions are about 8 inches long by ⅜ inch in diameter. Next pour about a half or a full teaspoon of water in the open end and manipulate the tube until the water is in the closed end and then rotate the other end in a bunsen burner until the open end gets quite small; in fact, so small that the wire which is finally to be placed there will just slip in and out.

Next put the end with the water in over the burner and allow it to boil until the



The Price of Geissler Tubes, as Is Well Known, Is at Present Almost Prohibitive—and the Present Article Dealing With a Home-made Vacuum Tube for Illumination on Spark Coils, Etc., Comes at an Opportune Time.

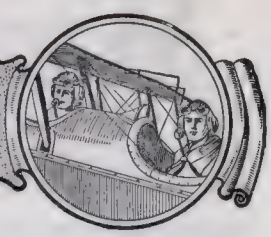
water is most gone, then quickly insert the wire and fuse it there. Now then as the tube cools the steam which filled the entire tube will condense, leaving a vacuum in the tube, and the result if the directions are carefully carried out is a serviceable Geissler tube.

However, the tube must be kept in a triangle shaped condition or the water will short-circuit the high tension current.

Another much more commendable way is to use kerosene, gasoline, etc., instead of water, as the remaining liquid is an insulator and consequently the tube may be put in any position.

Contributed by LAWRENCE O. DENIO.

RADIO DEPARTMENT



Latest Radio News

NEW YORK UNIVERSITY FIELD RADIO.

THE photograph here reproduced shows the great interest manifested by members and visitors in the New York Universitiy Reserve Officers Training Corps, members of which are hereby seen operating a field wireless set during the recent drills held at that institution in New York City.

The accompanying photograph shows a wireless telephone used as an aid to "fire fighters." A demonstration was recently given in England showing how wireless telephony can be used in connection with fire fighting. Communication can immediately be establisht between the scene of the fire and headquarters, and additional equipment, ambulances, doctors, etc., called at once. This photo shows a member of the crew talking with headquarters seven miles away. A very good test, indeed.

Thanks to the high sensitivity and reliability of the multiple stage Audion detectors and amplifiers now available in the radio field, such work as this can be readily carried on without the huge antenna spreads of a decade ago, elevated to considerable heights. During the World War, it was frequently demonstrated that radio-communication over a distance of 25 to 100 miles could be carried on accurately by wireless, even when transmitted and received from an antenna supported by a 15 to 20 foot mast on a radio motor truck.

Of course, the higher the antenna the better the results obtained, generally speaking. It is interesting to note in the accompanying photo, how the ground connection is made—this as will be seen, was formed of two large wire masts, such as fine mesh, or other metal wire mesh which is placed on damp ground, or on grass or other vegetation, whenever possible.

It is also interesting to recollect that very excellent results were obtained some time ago by American radio engineers who made tests with aerial wires laid on the ground, which worked particularly well laid on grass, owing to the fact that a first class connection with the earth was then established. In using the antenna wires laid on the ground, the regular earth connection was generally employed, the ground wire being connected to an iron stake driven into the earth, or else to some earthed pipes system. Messages were transmitted over short distances successfully in this manner, using no elevated antenna whatever, and reception was carried on over distances of several hundred miles.

Later improvements, as carried out by Dr. James Harris Rogers and other radio investigators have brought to light the fact that ground antennae—either those laid on the ground or else buried under the ground—will do equally as good work, and in some cases give even better results, than the aerial elevated at a great height. One of the big outstanding features of the ground antenna, whether of the surface or buried type, is that radio reception may be carried on thru a very severe static and in fact in thunder-storms, which is practically impossible with other radio antennae.

New York University's Field Wireless—Members of New York University Reserve Officers Training Corps Operating a Field Wireless Set During the Competition Drills Held There Recently.

A Demonstration Was Given in England Showing How Wireless Telephony Can Be Used in Connection With Fire Fighting. This Photo Shows a Member of the Crew Talking With Headquarters Seven Miles Away.

Photos from Underwood & Underwood

It is to be hoped that every educational institution in the United States will for many years to come, follow the movement started since the end of the World War, and see to it that the young men which they are training and will train in the engineering and other lines, which are so extremely valuable to our army or navy in wartime, are thoroly acquainted with the military requirements of their government.

We do not believe that the military training given to members of the university and other officers reserve corps will lead to any undue aspirations as was the case in the past 40 years in Germany. The spirit of unabated Militarism apparently there reached its maximum, but under the conditions in which we find our own country, and in which way we DID find it, much to our dismay when we had to declare war, it is nothing short of criminal and foolhardiness to look the facts in the face and not train our own manhood so that they know how to handle a gun, what a Radio Set looks like, how submarines may be detected and located by a simple telephonic device, how to aim a gun so as to hit an enemy even beyond a mountain, the target never being seen by the gunner, etc., on down thru the list of military tactics and maneuvres which every army and navy man must have some knowledge of to fulfil his duties properly. And every one of us knows that these men cannot be trained in a day, nor a month or even six months.

Articles In August "Radio News"

Anti Capacity Winding vs. Coil Efficiency — *By Oscar C. Roos*

Japanese Radio Apparatus

A Trans-Oceanic Receiver — *By F. J. Rumford*

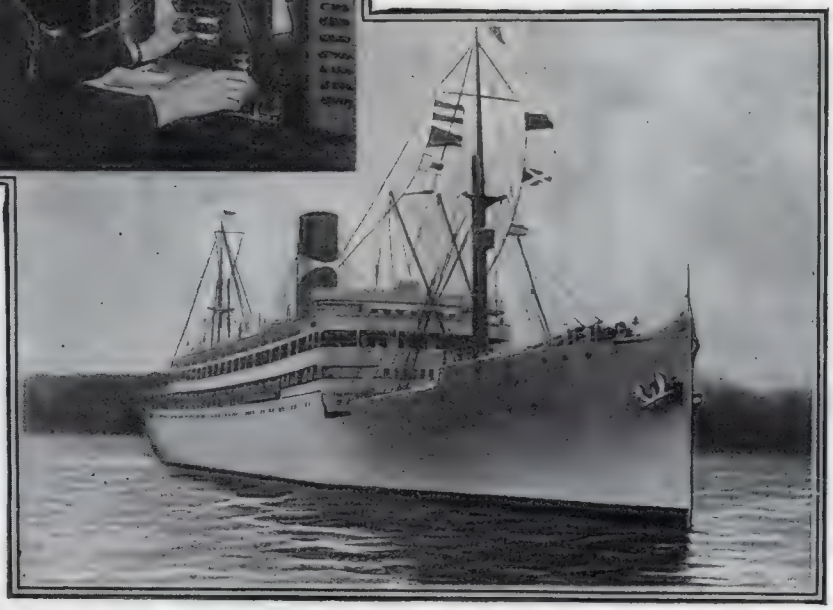
The Simplest Hook-Up—By Thos. W. Benson and Chas. S. Wolfe

The Radiophone on Roller Chairs — *By Harold Warren*

Design of a Radio Receiver—Part 2 — *By L. M. Clement*

Static Defeated! — *By Arthur H. Lynch*

Wireless Telephony on Shipboard



The Wireless Telephone on the S. S. "Ulua" Proved of Great Use to Her Passengers. One of the Splendid Features of the S. S. "Ulua," of the United Fruit Line, the Floating Palace of the Great White Fleet, Which Arrived in New York Harbor Recently on Its Maiden Voyage from Glasgow, Scotland, is Its Wireless Telephone Service. The Photo at Top Shows One of the Passengers While Out at Sea, Connected With His New York Office by Means of the "Wireless Telephone." Photo at Right Shows the S. S. "Ulua," the Wireless Antenna Showing Clearly Between the Mast Heads. The Currents Received on the Antenna Are Carried Down to the Radio Room by Means of a Heavy Cable.

A FEW years ago, the wireless telephone was thought to be merely a delicate laboratory apparatus, requiring the very finest operating conditions for its successful operation, but the accompanying photographs show to what an extent the practicability of the radiophone has been carried.

The first picture shows a recent arrival in the United States, the S. S. *Ulua* of the United Fruit Line, often called the "Floating Palace" of the Great White Fleet,—which recently arrived in New York Harbor on its maiden voyage, equipt with the new wireless telephone shown in one of the accompanying photographs.

The photo showing the radio telephone apparatus installed in the wireless cabin on shipboard, shows one of the passengers while out at sea, talking to his New York office, by means of the wireless telephone.

RADIO SET THAT SENT PRESIDENT'S EPOCHAL MESSAGE.

A wireless set which for the first time made telephoning from sea possible and which sent President Wilson's historic message across the water to Washington is now in the research laboratory of the General Electric Company at Schenectady where it was developed by J. H. Payne, Jr., a 26-year old radio expert who was called from college to help the company to serve the government during the war. The laboratory group with which he worked did much toward making wireless telephony possible between aircraft, by cutting the size and weight of the equipment in half.

In February 1919, he devoted his attention to perfecting a wireless telephone transmitting apparatus with powerful generating tubes for ocean use.

His tests were made from the presidential liner *George Washington*. Payne took the set on two round trips during which not only was the set improved to meet varying weather but it was duplexed with a pair of antennas on board ship and a similar pair at the naval radio station in New Brunswick, so that messages could be sent and received just as they are over an ordinary telephone without switching, as had previously been necessary.

On the return lap of the first round trip, Mr. Payne, over a distance of 500 miles on May 4, 1919, sent the first commercial message ever forwarded by radiophone. It read: "From U. S. S. George Washington via Otter Cliffs, Me. 4. To Perkins, 242 W. 72d, N. Y. Expect to see you Monday night. Love. Signed, Ted. 3:30 p.m." On the following day Secretary of War Baker who was aboard, put on the headset and talked from a point 200 miles out of New York, to Asst. Secretary of War Franklin D. Roosevelt in Washington. Payne's log says the conversation proceeded "as easily as over an ordinary telephone."

Mr. Payne and the outfit returned to France with the ship to bring President Wilson home from the peace conference. The *George Washington* left Brest June 29. When the ship was 1,000 miles from Bar Harbor, Me., the set transmitted phonograph music so distinctly that sailors in Bar Harbor danced to it.

However, on July 8, just as the Atlantic fleet was greeting the *George Washington* off New York, the epoch marking official conversation was successfully held with Secretary Roosevelt in Washington and the President "Was delighted."

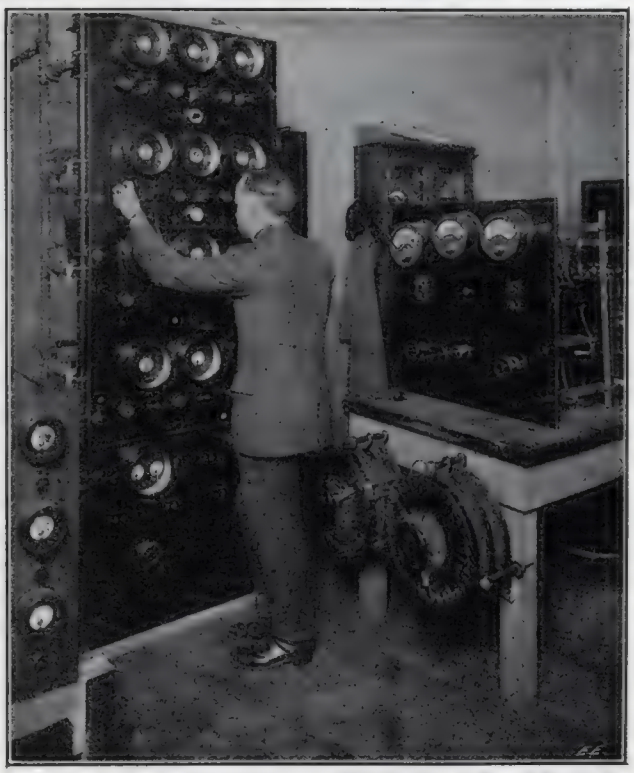


Photo in Lower Right Position Shows the Wireless Telephone Installation on the S. S. "George Washington," by Means of Which President Wilson Was Enabled to Talk Across the Atlantic Ocean to Washington, D. C. When the "George Washington" was 1,000 Miles from Bar Harbor, Me., Homeward Bound, This Set Successfully Transmitted Phonograph Music so Distinctly That Sailors in Bar Harbor Danced to It. The Set Included a Large Bank of "Pliotron" Vacuum Tubes, Which, When Connected Together, Enable a Large Amount of Energy to be Easily Controlled by the Voice.

Photo Courtesy of General Electric Co.

AUDION POEM AWARDS

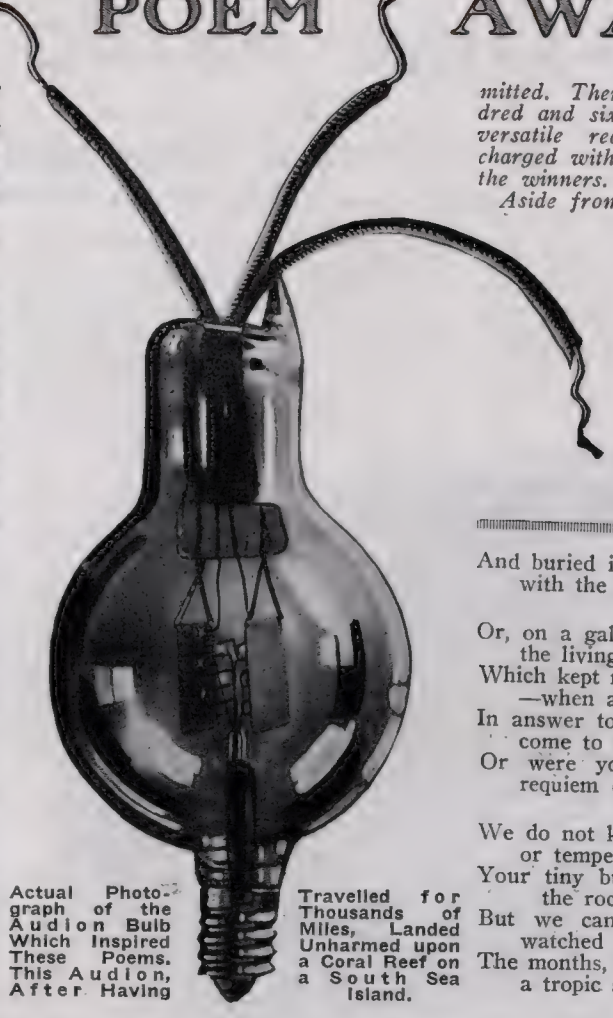
IN our March issue we publisht a letter from Dr. Lee de Forest, as well as a communication from R. A. Travers of Washington Island, which is in the South Seas. Mr. Travers had sent Dr. de Forest an audion bulb which had been washed ashore after bobbing over a coral reef, terminating its voyage of many thousand miles.

Dr. de Forest was so imprest by the wonderful pilgrimage of this little world wanderer that he suggested to us that the occasion should be duly commemorated by a fitting poem to the little adventurer. He accordingly thought the sum of $25.00 would be small indeed as the price of a befitting monument to our endearing hero.

But we were indeed surprised as to the quality and quantity of the poems submitted. There were no less than four hundred and sixty—a glowing tribute to our versatile readers. Dr. de Forest was charged with the arduous task of picking the winners.

Aside from being one of our great inventors, Dr. de Forest is also a poet of no mean accomplishments; his selections printed herewith prove this sufficiently.

We can, of course, not print all of the really good poems submitted—but we are making room for the nine best ones. The balance will appear in the September number. We know you will enjoy them.
—EDITOR.



Actual Photograph of the Audion Bulb Which Inspired These Poems. This Audion, After Having Travelled for Thousands of Miles, Landed Unharmed upon a Coral Reef on a South Sea Island.

$25.00 *Prize Winning Audion Poem*

FLOTSAM.

"Where should this music be? I' the air,
or the earth?
It sounds no more—and sure it waits upon
Some god of the island."
—*The Tempest, I, ii.*

WAVE-borne, a fragile thing of glass and wire,
Past the grim reefs that guard a lonely land,
The Audion drifted. Balked of its desire,
The spent sea washed it on the level sand.

The island took it to her warm embrace;
The palm-trees looked and wondered: "Hail, shipmate!
What wanderer are thou that the swift sea-race
Brings to our isle, sun-lit and desolate?"

The power that laughs at space was vibrant there;
Around the wanderer grew the wires again;
Answer came in the song of upper air—
The new-born Aerial of space-conq'ring men:

"My thin-faced master was a god to me,
Intent, deft-fingered, author of my breath
And my quick hearing—yet the ruthless sea
Took him, and tost me to a life in death.

Wrenched from my place, deaf, blinded, flung aside,
Wondering ever as I drifted why
I could not have gone down at that same tide
When my god sank—to die as captains die.

Still at their post—dying before reply
Could reach us sinking!—Now for me the while
No hope, save of escape from memory,
Beached on this murmurous, fair Pacific isle."

Composed by Kemper Hammond Broadus.

Special Honorable Mention

TO AN AUDION WASHED ASHORE.

Only a wanderer washed ashore, on the beach of a white sand key,
Where the warm night wind comes softly in from off the booming sea.
Only a wanderer stranded, where the ghostly palm trees sway,
But under the spell of the Southern Cross I heard the wanderer say:—

"I thrilled to the touch of my master's hands, and the tidings that came from afar,
While the old tramp steamer throbbed along, 'neath the cloud-dimmed Northern Star.
I hearked to the battle cruisers speak to their lean destroyer pack,
Where the thudding depth bombs marked the end of a cornered U-boat's track.
I heard the dreadnaughts' steel-tight towers, where the static glimmers clung,
While the hurricane droned thru the phosphor-bronze with the lay that the storm-god sung.
And I heard my masters call relief, ere I sunk in the surging brine
On the black, black day that we flung our bow on the horns of a floating mine.
The swirling maelstrom sent me free when the bursting boilers blew,
And I went a thousand weary leagues, ere I wandered here to you.
Ah, me, my masters wander still, where the cold ooze currents stream,
And the dead men go their silent ways, where the ghost-fire fishes gleam.
And thus I speak, while the moon is white, and the Southern Cross is high,
That the world may know that my masters died as the Wireless Men can die!"

Composed by Walter W. Stephen.

2nd Honorable Mention

THE WANDERER.

O little Audion, that sailed across the mighty sea,
A wondrous tale of wandering, you could reveal to me;
It may be by some careless hand that you were cast aside—
And buried in the sands until, you drifted with the tide.

Or, on a gallant ship, perhaps, yours was the living glow
Which kept men's hearts aflame with hope—when all around was woe!
In answer to their "S O S" did someone come to save?
Or were you left, alone, to chant—the requiem of the brave?

We do not know, nor can we tell, if tide or tempest bore
Your tiny bulb, so far from home, upon the rock-bound shore;
But we can fancy countless days, you watched the ships go by—
The months, in idle drifting spent, beneath a tropic sky.

You often found a shining path, made by the moonbeam, bright—
You loved the silver stars that gleamed, all thru the dreary night;
They seemed to be like comrades, there, up yonder, in the blue—
Who shared the hours of loneliness, and longed to comfort you!

Sometimes, by angry billows tost, in moments fraught with fear—
You trembled at the thunder crash, and deemed the end was near.
You mirrored every lightning flash, that rent black clouds in twain,
And wondered if your fragile bark, would stand the awful strain!

Yet, spite of storm and sore distress, your courage did not fail;
The sunshine always came again, and you forgot the gale.
Urged on by strange, resistless force, you westward sailed, to where
Three thousand miles, or more away, the coral reefs, lie bare.

O weary little wanderer, your journey, now is o'er.
Your message from that distant isle, sounds clearer than before.
You tell of power, unseen, unknown, a watchfulness Divine—
For all the world, a code, a creed. A tender loving sign.

That, whereso'er our paths may lead, though veiled in mystery—
The end will find us, safe at last; the voyage—memory.
Beyond the wind, and waves, we rest, content, because—we know
The Master's touch, will bring the thrill, the Light of Long Ago!

Composed by Emily Metcalf.

(*Continued on page* 456)

A War-Time Radio Detective

Part IV

By PIERRE H. BOUCHERON

FINAL RECITAL OF A MOBILE SPY SIGNALING OUTFIT

Down at the office of the L. C. D. they will tell you of the many startling cases which involved enemy spy systems having a strong radio background. Some may even rant about the baffling exploits of the "three musketeer spies" who had devised a system where, from several vantage points close to the huge Sperry Gyroscope Plant, strong magnetic waves had been "focused" upon the building in such a manner as to disable delicate testing instruments, thus effectively curtailing the production of much needed war apparatus. They will also tell you about many other strange and equally fantastic incidents. But I have it from very good authority that these wild and woolly impossibilities were in many instances the product of fertile imaginations.

As a matter of fact the most interesting cases entailing considerable time and expense in their solving, and which secured the most official notice, turned out to be some of the simplest and harmless happenings which were either coincidences or absolute false alarms. Judging purely from a matter of interest and narration, however, these proved to be the ones most worthy of recital for they involved the many characteristics which go toward making human nature the greatest of all scientific study and observation.

For that reason I might go on and rave indefinitely about innumerable cases, every one of them distinct from each other in its make-up and origin. Then, possibly, after the BORING point had been reached, the tables might be turned on me whereby the pursuer would become the pursued and countless numbers of otherwise genteel readers would track me to my lair, destroy my trusty typewriter and thus effectively put an end to these yarns. As I have no wish that this occur, I respectfully invite your attention to the following wind-up story:

". . . Suddenly and Without the Slightest Warning, the Spy's Right Foot Shot Out and Landed Squarely on the Chest of the Lawyer . . . Knocking Him Down . . . a Few Seconds Later the Purr of the Motor Was Heard and the Car Went Speeding Down the Road."

THE RADIO MYSTERY STARTS.

ONE day, a middle-aged and much excited gentleman dashed into the office, and for more than an hour was closeted with our chief. He had no sooner left when a colleague and myself were called in and a hurried conference held concerning the following very strange and interesting case.

The gentleman, who by the way was a very prominent lawyer of New York City, had been visiting friends in Long Island by automobile and upon returning had stopt at a roadhouse near Babylon for some refreshment. He gave his order to the waiter and in a short time this worthy returned and was in the act of arranging things on the table when another waiter came up to him rather hurriedly and speaking in a low tone said in French, *"La voiture vient de retourner,"* meaning, "the carriage has returned." The first waiter thereupon turned rather quickly and said, *"Très bien"* (very well), then, as if an afterthought had struck him, remarked, *Faisez attention, je vous ait déja dit que vous parlez trop fort"* (be careful, I have already told you that you speak too loud).

Now it happened that altho the above conversation had been carried on in monotones, the lawyer, who had spent the early part of his youth in France and who later on in life had made frequent visits there, was therefore well conversant with the French language and readily heard and understood what had been said. Incidentally he noted a decided Teutonic accent in the speech of the would-be French waiters. The lawyer had kept up a bantering talk with his companion while the incident had taken place and now purposely continued to do so in the hope that the waiters would say more. Nothing further was said, however, and the two waiters departed towards the back part of the room.

Ordinarily, an incident of this kind might have past unnoticed, particularly in a public restaurant, as it is a well-known fact that many waiters in metropolitan districts speak French and German as well as English. In fact, many will proudly tell you that in their European travels they have waited upon this and that prime minister, General So- and So and even King Whosthis. But in this case the lawyer wondered why these two individuals had used French when they were so evidently of German origin. Was it that English was not secretive enough and could have been too readily understood by chance persons sitting nearby, or was it that French had been employed because it offered less possibility of its being understood and at the same time could be heard by other persons without exciting suspicion? It would seem logical, of course, not to resort to German during the general suspicion of war-time, which is a language recognizable even by persons not able to speak or understand it. These things, coupled with the rather unusual remarks of the two waiters, caused the lawyer to decide that here was something going on which was evidently not meant or planned as an event to be heralded from nearby housetops.

He spoke to his companion about the matter and explained to him what had been said, whereupon they decided to call for the waiter in order to observe him at close range. The headwaiter dispatched someone to the internal regions and after a considerable period of time a strange and entirely new servant came who made haste to explain that our first waiter had "gone off watch" and that he would be pleased to attend to their further wants. In view of what had gone on this sounded exceedingly unconvincing and unsatisfactory, to say the least. When waiter number three had been sent for two additional highballs (alas, reader, this all happened before July, 1919!) it occurred to the lawyer that it might not be a bad idea to stroll outdoors and endeavor to obtain a close view of the "carriage," if such it be, referred to by the two pseudo-Frenchmen.

THE RADIO TRUCK DISCOVERED.

Outdoors, however, nothing unusual seemed to be going on. There was, of course, a considerable number of automobiles parked within the immediate vicinity, for that particular roadhouse happened to be a rather popular one, but none of them seemed particularly interesting. The lawyer walked about the place for a while, then finally decided to explore what appeared to be a small driveway leading to the back of the inn and which seemed to reach out toward considerable shrubbery and trees. After walking for a short space he suddenly heard the *chug chug* of an automobile motor and upon nearing the direction from which the sound came saw a large motor truck with canvas cover similar to the huge army motor-lorries. From the top of the machine and reaching thru the canvas covering was evidently a collapsible mast of several sections. Upon approaching nearer he noticed one of the canvas flaps had been opened which gave a fairly good view of what was going on inside. A considerable number of bulky instruments and a small table or shelf could easily be seen, over which sat two men intently interested in a certain piece of machinery. The whir of a high-speed motor could now also be plainly heard above the roar of the auto engine and intermingled with this whir were intermittent hissing noises which sounded very much like escaping steam. The lawyer thought these activities rather unusual in this section, for the outfit, which evidently was a portable or transient radio signaling unit, could hardly be connected with the army signal corps or any other authorized and official organization, particularly in view of the fact that the two men were not drest in uniform of any kind, being

clothed in rather unkempt civilian attire. From his point of vantage he continued to observe the strange couple and their activities, being at this point a considerable distance from the main road. For the time being he did not know just what to do in order to confirm his suspicions. To go back to his friend and explain the situation with a view of further investigation would have meant that by the time he would return, the traveling plant might have decampt to parts unknown. On the other hand, the outfit might possibly be part of a Government signal unit operated by civilians for the purpose of test communication or research work, and it would be placing himself in a ridiculous position to attempt to report it or interfere should this prove to be the case.

The best plan, therefore, was to walk up to the two men and under the guise of a curious inn guest wandering about for some fresh air, nonchalantly step up and ask questions. He shortly reached the rear part of the auto truck but the men having their backs to him did not become aware of his presence immediately and this fact gave him the opportunity to better observe and study the contents of the car and its occupants. A small portable drop lamp of the storage battery type hung from the top of the car and thus by its fairly bright light could be seen the entire interior. Altho the lawyer was not well versed in radio matters, his general knowledge of the subject, however, enabled him to recognize the installation and its purpose with reasonable certainty.

Judging from the general arrangement of the car, it had evidently been designed for extended trips and constant travel. On one side was a settee or couch, the base of which probably contained storage cells and tools. One of the men was making some sort of adjustment to one of the running pieces of apparatus while the other was sitting on a camp stool and, with the familiar head telephones common to radio signaling outfits, seemed to be "listening in." Finally the noise of the machine must have been too much for him for he reached over and stopt the motor. It was at this moment that the nearest man slowly turned his head as if sensing the immediate presence of some one. The lawyer was somewhat startled for the man was no other than the late versatile waiter. He looked surprised for a moment then rather abruptly asked what was wanted.

"Nothing," replied the lawyer, "just walking around for a little air. What kind of an outfit is this you have here?"

The man had gotten up from his position and slowly walked to the end of the car and stood up above the lawyer looking down at him and studying his face when suddenly, and without the slightest warning, his right foot shot out from its elevated position and landed squarely on the chest of the lawyer with great force knocking him down and for the moment stunning him out of his wits. A few seconds later, the purr of the motor was heard once more, the canvas flap was drawn down tightly, thereby excluding all light, the car lurched forward and in less time than it takes to tell was speeding down the by-road at a considerable rate of speed where it was soon lost in the darkness.

After recovering from his surprise and astonishment the lawyer got up and since pursuit was out of the question, slowly walked back to the inn. He had not thought it wise to make a hullabaloo of the incident to any one in the place, but instead went directly to his friend who had been patiently waiting for him. The lawyer sat down and related what had just occurred, whereupon the two decided that to attempt to report or phone the matter from this locality would probably not be a wise step. One thing was certain, the first strange conversation of the two waiters, the motor lorrie and its paraphernalia coupled with the rather impromptu way of the versatile waiter in disposing of curious onlookers, proved beyond a doubt that the car and its occupants were engaged in an illegal activity having to do with some sort of spy communication system. Under the circumstances the most logical thing to do was to personally report the matter to the Government officials directly interested in investigations of this nature.

That was the substance of the story which the lawyer had related to our chief and which we two were now familiar with. The case was gone over very carefully and it was finally decided that enemy agencies were engaged in seeking and transmitting information to possible submarines lurking off the coast of Long Island, and that in order to do this in a way which would be hard to detect, they had resorted to the novel use of the traveling radio installation previously described. Moreover, this fact was shortly confirmed when upon inquiry it was learned that neither the Army nor Navy had any portable units of this type operating in that vicinity under circumstances as previously related.

SUSPICIOUS RADIO SIGNALS

Incidentally, it was recalled that several of the Government radio stations on Long Island as well as those in Brooklyn had recently heard signals which sounded rather suspicious. These operated on a wavelength slightly above 700 meters, with a constantly fluctuating frequency, that is to say, gave the impression of emanating from a portable motor-generator unit, similar to those employed by the Army Signal Corps. Some types have hand-operated motor-generators whereupon as soon as the operator presses the key of the transmitting circuit the beginning of a dash will have a frequency somewhere around 800 cycles but will immediately drop down to perhaps 400. This characteristic will give a somewhat fantastic sound to long series of dots and dashes. It was also recalled that these particular signals had no real sequence, being composed mostly of intermingled numerals and letters. They were not recognized as pertaining to any Army or Navy signal codes or ciphers.

It was, therefore, very logical to infer that these strange and suspicious signals probably originated with the traveling radio station. This fact had been confirmed by resultant radio compass bearings which gave greatly varying positions every time they were intercepted. The regular means of investigating signals of unknown origin decidedly could not be employed in this instance, for it was recognized that we were dealing with persons who had made a close study of American communication systems, and that they were experts in the art of eluding detection. This case would therefore entail a different procedure and would necessitate the employment of many men as compared with the usual cases which could easily be covered by one or two investigators. The plan decided upon, therefore, was to erect several radio compass listening-in stations in the vicinity of Bay Shore, Babylon, Amityville and other points further east on the island. These stations were to maintain a constant "watch" and immediately upon securing approximate bearings of any unrecognizable or suspicious signals, report them to another body of men furnished with automobiles whose duty it would be to immediately dash out to the suspected spots and endeavor to corral the strange acting motor truck. This was the substance of the proposed operations. Incidentally, we were told to "work fast," for, since there were many military and naval establishments on Long Island it would not do to have their activities ascertained and reported to enemy intelligence systems for any length of time without resulting in possible dangerous consequences.

Naval intelligence men were accordingly dispatched to their individual points of vantage and the above-mentioned portable radio compasses were set up at the most advantageous sections. My good friend and coworker J. T. H. and myself sallied forth to win recognition and fame on this latest exploit which certainly did promise interesting developments.

A MERRY CHASE

Days rolled by, then weeks which were filled with some most breathless and intense moments. Excitement was the order of the day. At any hour of the day and night our radio compass operators would report bearings on suspicious signals whereupon we would spurt to the given spots only to find our birds had flown. This was to be expected, of course, for the very act of the radio spies in using the traveling outfit was designed to evade all possible detection by means of the radio compass. We hoped, however, that we would eventually run across the motor lorrie, for our system was such that with the great number of men now working on the case such a large truck could not evade us much longer. Not only that, but we were working in connection with the Army so that possible disguise or camouflage on the part of the truck could have been readily detected. The great disadvantage was that our activities might

". . . Lo and Behold, There in the Center of the Cleared Space Was a Large Mass of Twisted Steel and Charred Wood. . . . Was This the Spy Radio Truck Discovered at Last—But Too Late?"

(*Continued on page* 457)

MAGNAVOX BOOSTS RADIO SIGNALS

Fig. 1. One Form of the Famous Magnavox Loud Speaking Telephone Which is Adaptable to Boosting Radio Signals or Ordinary Telephone Conversation, Etc., is Shown in the Accompanying Illustration. The Magnavox Used to Reproduce Received Radio Signals So That They Can Be Heard Over a Distance of Over a Hundred Feet Up to Several Blocks or More, Resembles That Here Shown, With the Exception That the Wires Leading to the Hand-microphone Shown at the Right of the Picture Are Connected to a Special Step-down Transformer, the Primary of Which Is Connected to the Regular Audion Amplifier.

IT was by means of Magnavox telemegafones that Lieut. Herbert E. Metcalf, 3,000 feet overhead, startled the city of Washington on April 21, 1919, by reading, via radio, President Wilson's Victory Loan message from an airplane in flight. The voice was distinctly heard by 20,000 people below. This feat was accomplisht thru the installation of Magnavox sound-amplifying apparatus in front of the Treasury Department Building. Every word uttered by the army officer in his radio-telephone was caught and swelled in volume by the telemegafones below, until persons blocks away could hear the message plainly.

Now comes the complete Radio Telemegafone, which enables radio operators to do without their head-sets and hear every ordinary signal easily by means of a telemegafone standing on the receiving table.

There are at present manufactured two forms of sound-amplifying apparatus. These are: The radio telemegafone, Type R-1 or R-2, as described below, and the voice and music telemegafone, MV-1, illustrated at Fig. 1, herewith.

The radio telemegafone, equipt with both head-set and horn, is designed particularly for use by the following: Commercial stations, ships, technical schools and colleges, experimental radio stations, radio amateurs, radio-apparatus manufacturers. This type of telemegafone will appeal strongly to radio engineers, operators and manufacturers, because:

With the telemegafone standing on the receiving table, an operator can read signals as plainly as he can those that ordinarily come thru head-receivers. With the Magnavox telemegafone's head-set attached he can easily read weak signals. The gain in comfort to the operator by using the telemegafone for ordinary signals is self-evident.

By using proper current-amplifying apparatus, any signals can be amplified and reproduced thru the telemegafone to a volume too great to be adequately measured or even estimated. In fact, *signals can be heard thousands of feet from the horn!*

When extremely loud reproduction is desired, the radio telemegafone type R-2 is recommended, with its wooden horn having a mouth 22 inches in diameter. This type is identical with the R-1, save in this feature. It gives the maximum clearness for distributing sound to outdoor audiences or in a large auditorium. Either the type R-1 or type R-2 may be used with a one- or two-stage audion amplifier of the type used with most radio receiving sets, or it may be used with more elaborate amplifying apparatus according to the degree of loudness desired. The makers of the Magnavox supply when desired a three-stage audio frequency amplifier with two tubes in each stage.

This amplifier is particularly adapted for use in connection with Magnavox telemegafones.

This type radio set consists of: One telemegafone, one metal horn, 17 inches long with mouth 6 inches in diameter, one listening tube headset, one special step-down induction coil and battery switch, mounted on base with telemegafone.

A six-volt storage battery is required to furnish current to energize the powerful electro-magnet of the telemegafone. The leads from the battery are connected to terminals marked B-B in Fig. 3, which in turn are connected to the field coil of the telemegafone.

The *electro-dynamic* principle has in the past superseded the *electro-magnetic* principle in almost every form of electrical apparatus employed for the transformation of electrical energy into mechanical energy.

The startling results obtained with Magnavox dynamic receivers indicate that this type is destined rapidly to supersede the commonly used electro-magnetic or Bell type of receiver.

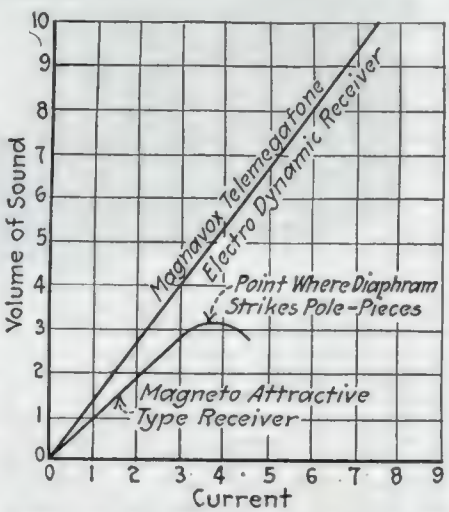


Fig. 2. Graphic Curves Which Show Clearly the Wonderful Range of the Magnavox Telemegafone, or "Electro-Dynamic" Receiver, as Compared to the Standard Type of Magneto-Attraction Telephone Receiver. Note That at Slightly More Than Three Units of Sound Volume, the Diafram Strikes the Pole-pieces in the Usual Form of Receiver.

The telemegafone (distant megaphone), which is the name given the Magnavox electro-dynamic loud-speaking receiver, con-

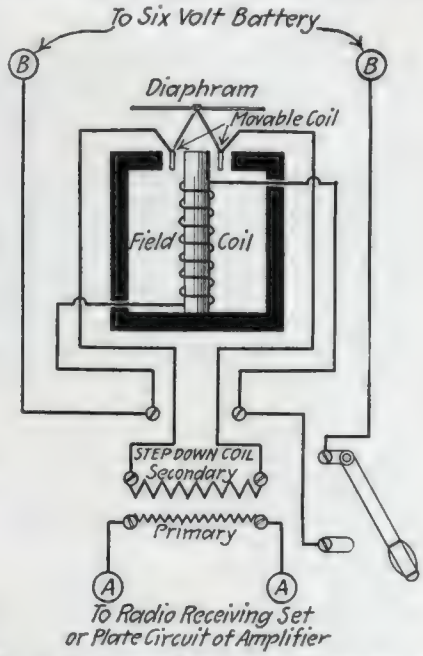


Fig. 3. Hook-up of Magnavox Telemegafone with Special Step-down Transformer, Switch, Etc., to Radio Receiving Set.

sists of an ironclad electro-magnet provided with a narrow circular airgap in which exists a dense magnetic field. A circular-shaped, light, movable coil is suspended in this airgap and is firmly attached to the diafram enclosed in the sound box. When the variable currents flow thru the movable diafram coil it will move in accordance with the characteristics of the incoming variable currents. The diafram, being firmly attached to the coil, will reproduce the signals. (See Fig. 3.)

The construction of the electro-dynamic receiver permits the diafram to move as far as the natural resiliency of its material will permit. (German silver or phosphor bronze diaframs are suitable.)

The diafram in an electro-magnet or Bell type of receiver can vibrate only up to the point where it will begin to strike the pole-pieces. If the pole-pieces are removed further from the diafram the receiver will rapidly lose in sensitiveness. (See curve, Fig. 2.)

The receiving coil of the telemegafone is wound so as to have a direct-current resistance of about ten ohms. This necessitates the use of a special step-down transformer or induction coil. The step-down coil, which is used in the R-1 or R-2 set in connection with a type LS-2 telemegafone, is wound in sections to decrease the capacity effect of the coil. The primary winding, which is connected to the terminals marked A-A in Fig. 3, and from there connected to the radio-receiving apparatus, is wound with about 1500 ohms, direct-current resistance, of No. 35 B. & S. gauge insulated copper wire, wound in nine sections.

The secondary winding is connected to the light movable coil of the telemegafone and is comparatively short. It is wound with No. 22 wire in six sections. The length of the secondary winding is such that maximum effect is obtained in the telemegafone. The instrument shown at Fig. 1 is intended for amplifying the spoken voice or phonograph music, but resembles identically in principle the radio type.

Large Photograph Below Shows General Experimental Room of the Hanover Scientific Club.

In the Rear Left - Hand Corner of the Photo Above, Appears the Wireless Table of the Hanover Scientific Club, With its Long Wave Tuning Coils and Loose Couplers. In the Extreme End of This View, Appears a Reading Table and Library Room Which is Formed by Drawing the Curtains Together. Many Text Books and Magazines Are Available at All Times to the Members.

At the Right-Hand Side of the Photo Above, May Be Seen the Vapor Hood Used by the Electro-Chemical Students of the Hanover Scientific Club, in Making Gas Experiments. The Sink is Equipt With Hot and Cold Water and Gas, and a Large Basin for Draining the Water.

The Hanover Scientific Club

HEREWITH we, members of the *Hanover (Pennsylvania) Scientific Club*, submit a brief description of our club and experimental laboratory. Our laboratory is in the largest building and in the heart of Hanover, Pa. We have ample room for all of our members which at present number nine active and three honorary.

In the large photograph can be seen some of the members engaged in experimental research. On the right-hand side are work benches, which are occupied by members studying chemistry. Each bench is furnisht with a gas and electric outlet and a large drawer in which their smaller apparatus and miscellaneous parts are kept. Each member also has a separate locker to keep his larger apparatus and belongings in. In the center is a table which is used by those members experimenting in electricity. The small motion-picture machine on the left-hand corner of the table, with its films, is used for lecture work and general amusement. The antenna under the table is in readiness to be strung between the two large towers on the roof of the five-story building. On the table can be seen Oudin coils, Leyden jars, interrupters, spark coils and transformers, storage batteries, wireless parts, magnetos, generators and everything a live experimenter needs. The table is also equipt with drawers in which the usual "junk" is kept. In the rear left-hand corner of the second photo is the wireless table with its long tuning coils and transformers and couplers. In the extreme end of this view appears the reading table and library room, which is formed by drawing the curtains together. Text-books of many descriptions are found on the shelves just above the table. The ELECTRICAL EXPERIMENTER (Science and Invention) and the *Radio News* are among the most popular magazines.

In the third photo, on the right-hand side, is the vapor hood used by the electro-chemical students in gas experiments. This sink is equipt with hot and cold water and gas and a large basin for draining the water. In front of the fireproof door stands the president (right) and the vice-president (left). The switchboard along the wall controls all current in the laboratory, both alternating and direct 110 and 220 volts. On the window in the rear is a motor-generator used for special direct current work and battery charging. The shelves on the left contains any kind of electrical junk from a binding post to a polarized relay, and such raw material as zinc, copper, iron, lead and aluminum sheets. Meetings are held every Thursday, all chartered members have keys and entrance can be had at any time. The students in chemistry are under the supervision of a college professor and regular progressive lessons are given. A Wireless Class has recently been formed.

The plan of effecting the organization in every town and city of all the scientifically inclined young men, is a most commendable one and one that merits and invariably does receive, the full support of the local officers of the municipal and town governments. Among the many other features resulting from the banding together of a number of young men interested in similar ideas, we find the following:

In the first place, a club such as this can always purchase material and instruments when necessary beyond the reach of the average experimenter, and which apparatus is frequently very necessary and important, in order to carry out certain research problems.

But aside from this, there are many other educational and intellectual features connected with any whole-hearted organization where each one of the students strives to do his best and the utmost to build up a solid feeling of brotherhood.

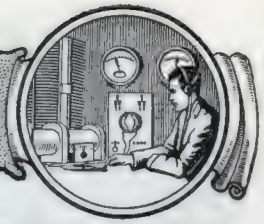
Any reader wishing to communicate with the club should address E. J. J. Gobrecht, President, Hanover Scientific Club, Boys' Club Bldg., Hanover, Pa.

SPECIAL LABORATORY PRIZE CONTEST.

As announced some months ago, we stated that for special experimental laboratory photos and descriptions an extra inducement or special prize would be offered. This month, we have pleasure in presenting an exceptionally fine experimental laboratory group, THE HANOVER SCIENTIFIC CLUB. We hope to receive more of these complete laboratory write-ups every month, and shall offer a cash prize of $10.00 for the best description, accompanied by photos, submitted.

Send photos and descriptions to Editor of "Special Laboratory Prize Contest."

WITH the AMATEURS

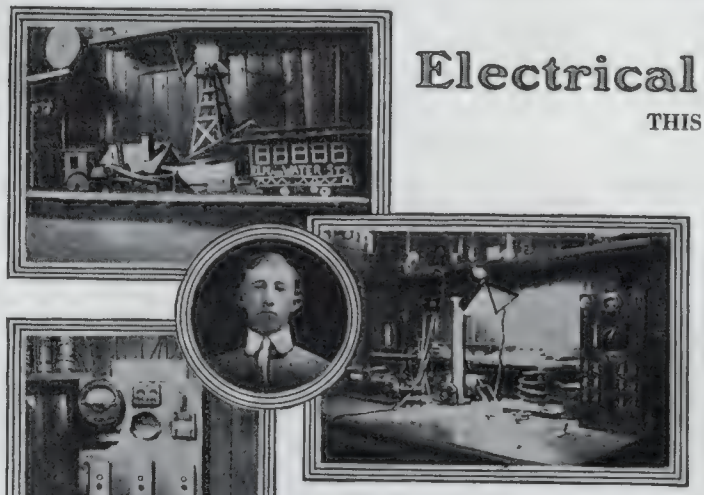


Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $5.00 each month for the best photo or photos and $2.00 to each "Honorable Mention." Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $5.00 PRIZE WINNER—

EARL H. FURMAN



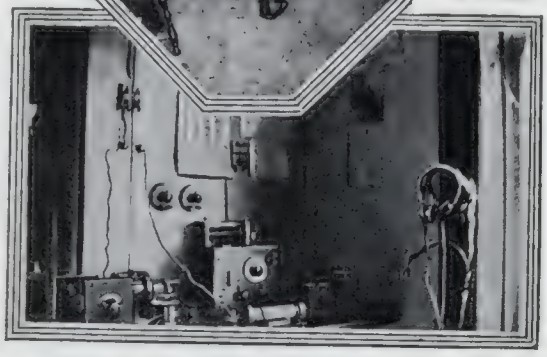
HERE are several pictures of my "Electrical Lab." My wireless receiving set consists of an Audion bulb detector, loose-coupler, Murdock variable condenser, fixt variable condenser, a pair of Murdock receivers, and various loading coils made by myself. The sending set is very simple, consisting only of a spark coil, condenser, spark gap, and key. See photos at left.

My aerial comprises four wires about 200 feet long and 50 feet high.

At the left of the wireless table is a small telephone which is hooked on with our house 'phone. On the right of the wireless table is a small transformer-switchboard with ammeter, fuses, small electric light and twelve binding posts, enabling a person to obtain any voltage from two to twenty. The large switchboard is over five feet high. It has on it the meter, fuses and switches to all lights in the "lab." It also carries the door bell, binding posts and receptacles for 110 volts, and a bell-ringing transformer. Another photo shows a miniature thrashing machine and separator. The engine is run by a small motor inside the boiler. The street car is run by a motor and reverses automatically. I also have a small farm yard consisting of an electrically lighted house, windmill, barn and other buildings.

Everything shown on this table was made by myself. One of the photos shows the work table and tools, which need no explanation.

Mr. Earl H. Furman, Box 112, Norcatur, Kansas.



HONORABLE MENTION—
EDWARD SLEPIAN
$2.00 PRIZE

I PRESENT herewith photos of my laboratory. My electrical workshop consists of a small table, a vise, and my tools which are situated above it. I have two receiving sets. The first consists of a double slide tuner, a detector which is home-made, an E. I. Co. fixt condenser, and an 85 ohm phone. My second set is composed of an 800 meter loose coupler, fixt condenser, Murdock variable condenser, two loading coils of 5,000 meters each, and a home-made loading coil of 15,000 meters. I also have a home-made Audion panel detector set. Among my electrical apparatus I have a 6-volt magneto and an assortment of switches, lamps, bulbs and nineteen cigar boxes full of "junk."

My transmitting set consists of a Ford spark coil, key, helix and a Leyden jar of one pint capacity. For "juice" I have ten Red Seal dry cells.

My chemical laboratory is built up from fifty-two chemicals, glassware and a zinc aspirator which I use in experimenting with chlorin, etc. I also have a large supply of copper wire, including some small pieces of platinum, German silver wire and nickel wire.

Hanging from the ceiling are two airplanes, one of which is three feet long and another of seven feet long with a wing spread of eight feet. Also a model dirigible which is under course of construction.

The photos of my laboratory shown at the right, do not do it justice, as I have a great deal more material and apparatus than is here visible. I have among other things an excellent collection of text books of electrical and chemical subjects, and find it very interesting to spend my spare moments in trying out new experiments and researches in chemical, electrical and radio work. One of the first things that the average experimenter needs badly is a good collection of tools. These do not have to be expensive tools, but they should be selected when you buy them so as to be of fairly good quality, and also adapted to all of the different work which you can think of. You will also need a good nest of screw drivers, from the smallest to the largest, and from four to eight sizes, form a very good set. In the plier family one will always find use for a liberal assortment.

I also receive regularly an assortment of five magazines among which are the ELECTRICAL EXPERIMENTER (Science and Invention) and *Radio News*.—Edward Slepian, 5007 Sixth Ave., Brooklyn, N. Y.

What To Invent

By JAY G. HOBSON

BOLL WEEVIL ERADICATOR.

TWENTY-EIGHT years ago in the year of 1892, some little fly-like bugs flew over the Rio Grande from Mexico and settled themselves down in the Texas cotton fields nearest the border. For several years thereafter they

Find a Good Means of Destroying the Cotton Boll Weevil, and Reap a Fortune.

were content in raising a few million children on the valued cotton plants, but as their flock of descendants increased faster than even they first dared to anticipate, new and larger fields of cotton became necessary to maintain them, so every year thereafter a few million children moved further North until today they are a very serious pest all over the Southern cotton growing states.

Under favorable conditions it is about one dozen days from egg to mature weevil. In a season, which is about three summer months, one pair of weevils can give birth to over 10,000,000. They can go six months without food if necessary. The weevil is one-fourth inch long and has wings like the familiar house-fly. The female weevil lays eggs in the fruit of the cotton plant. She bores a small hole in the pod or flower of the plant with her nose, then reverses ends and deposits an egg in the hole. This egg hatches into a little worm in about three days. This worm or infant weevil eats the delicate cotton boll, which is not matured, and here is where the great damage to the valuable crop is done.

Millions of dollars worth of cotton is destroyed each year by these parasites, and strange as it may seem, even our greatest scientists have been unable to cope with them. Numerous schemes for their elimination have been offered without success. This year they promise to prove more destructive than ever. Recently the United States Department of Agriculture announced years of experiments have shown that dusting the fields with "calcium arsenate" is the only way to stop the weevil. The Government says that "calcium arsenate" is the only means by which to poison them. However, this preparation is not successful in preventing over ten per cent of the weevils' destruction of the cotton.

Some other plan or device must be forthcoming soon or within a few years cotton growing will be impossible—and this means a calamity.

The peculiar feeding habits of the weevil makes it difficult to reach his vital spot with poisons. The punctures the female weevil makes in the square and boll of the cotton plant to eat the tender tissues therein and to lay eggs, kills the plant.

Because this tender part of the plant is covered with tougher tissues which the weevil don't eat, it is impossible to inject the poison into the pod, or flower, without spoiling the cotton at maturity.

One important thing the Government learned was that the weevil drinks lots of water. Dew drops and other water on the leaves supply his aqua pura. Working with this in mind, scientists began to experiment with spraying poisons in powder form over the plants which would mix with the moistures. When the weevil drank the liquid the poison would kill them. But so far this method has failed to produce the desired result because the poison employed is not the preparation required to eradicate the pest. Some other means must be found very soon to save the cotton.

The inventor who can bring forth a reasonable preparation, a plan, a device or process that will eliminate the weevil can soon enjoy world-wide fame and fortune. Most any of the cotton growing states would gladly pay one million dollars for a sure eradication, because many times more than this amount is lost yearly from the ravages of the weevil.

To be sure, it is a tremendous achievement, but I am confident before long some American inventor will solve the problem. It appears to me the logical plan to follow is for some proper chemical, rather than mechanical, as the weevils are not attracted at night by bright lights, like other insects, and they are too small to be caught in a mechanical device, unless it could embrace some preparation sufficiently enticing to draw them to it.

A SUBSTITUTE FOR GASOLINE.

Quoting from the Washington, D. C., *Post*, the importance of a gasoline substitute for automobiles is absolutely necessary if the indispensable power wagon is to be continued. We read as follows:

"A substitute for gasoline as a motor fuel obviously must be found, and scientists should be encouraged to work for that end. The public should not be left at the mercy of the oil producers and speculators, nor should it be compelled to pay unreasonable prices for its fuel. Long since the automobile ceased to be a luxury, and past into the necessity class. It now ranks with the telephone in the ordinary affairs of life. Within a few years, if road building continues and if the motor truck becomes the factor in transportation which is predicted for it, the automobile will pass on into a higher class and rank with the railroads as a public utility of vital necessity to the public. Therefore the high price of gasoline is not merely a question affecting the activities of joy riders. It is a matter of serious concern to the people."

We all can recall several newspaper accounts of discoveries that were going to bring the price of gasoline down to a few cents per gallon, or drive it into oblivion altogether. But King Gasoline is still on deck, more domineering and "exclusive" than ever. No practical substitute has been found, which leaves us exactly where we were years ago, *when eleven cents a gallon for gas was considered high.* Comparing eleven cents then with thirty-five cents now, makes a fellow feel that we did not know when we were well off. But the present high figure is a fact, and not a theory, which brings us face to face with the importance of a gasoline substitute.

Simple Glass Grapefruit Guard, to Prevent Squirting the Juice in Your Neighbor's Eyes.

Undoubtedly there is a practical substitute for Nature's power-juice. What and Where, of course, is the question, but I am confident it will be found within a few years, for anything under the sun is possible, except perpetual motion, and it wouldn't surprise me to learn that that, too, had appeared.

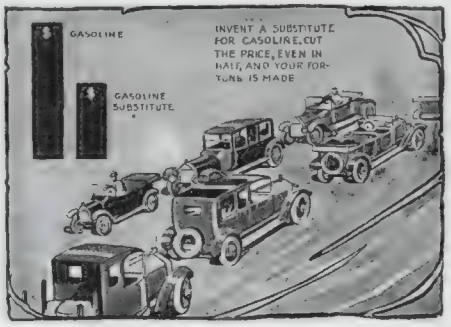
Down in Texas, where they miss oil sometimes and find gas, there has been developed a practical process of extracting gasoline from natural gas. Known as "casing-head gasoline," gasoline secured from the natural gas as it flows thru the casing or pipe. Evidently some automatic process of liquidation takes place in the gas as it travels thru the metal pipes.

It appears to me feasible to construct a device that will so compress natural and artificial gas that the hydrogen or gasoline liquid contents of same can be collected and stored for use in driving automobiles.

A device in the form of a powerful compressor so constructed that it will take natural gas from the well, turning it into a liquid form to be used as gasoline is used today.

There are millions of automobiles used daily, depending upon gasoline for fuel. This great army of consumers would gladly buy a practical gasoline substitute, and the inventor who succeeds in discovering one that will give satisfaction in power, and cost less, will be handsomely rewarded both with fame and with fortune.

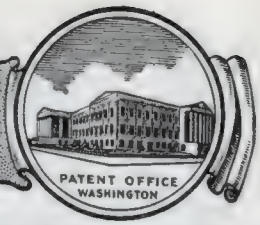
(*Continued on page* 440)



What a Fortune Awaits the Genius Who Gives Us a "Real" and Cheap Gasoline Substitute!

Copyrighted by Jay G. Hobson, 1920.

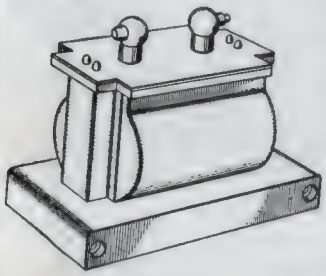
LATEST PATENTS



X-Ray Transformer.

(No. 1,337,885, issued to William D. Coolidge.)

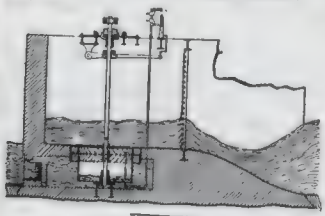
This invention relates to casings for portable transformers which are adapted for use in connection with X-ray work and its specific object is to produce a casing which is small and light having but little internal clearance and hence, follows the form of the core and windings closely. In this manner, but a small quantity of oil is necessary to completely insulate the windings, and keep the transformer cool. The top is made large to provide for ample radiation and the middle of the secondary winding is so arranged so that a milli-ammeter can be inserted in the proper position viz—between the windings.



Wave or Tide Motor.

(No. 1,338,326, issued to Frederick G. Peck.)

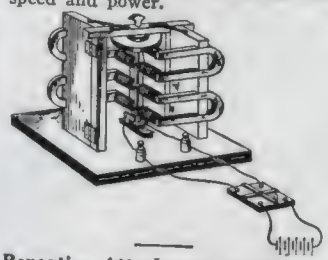
This tide motor is located in a peculiar shaped recess made of concrete so that waves coming toward the shore will be concentrated into a small area. These dash thru flap-gates, making the water within the chamber considerably higher than the surrounding water when, the crest of the wave falls. A very large turbine using but a small head of water is operated by the water thus caught. A novel method of keeping a constant water-head is employed, in that the turbine itself is buoyed up by a large air chamber. Whenever the water rises higher within the confining compartment, the weight upon the turbine becomes greater and immediately the turbine sinks. This actuates a valve-like mechanism which forces air into the buoying chamber raising the turbine back to normal. Should the water-head above fall, another valve allows for the escape of air, lowering the turbine. A basin in back of the chamber takes up the used water.



Electric Motor.

No. 1,337,686, issued to Solomon Boardman.)

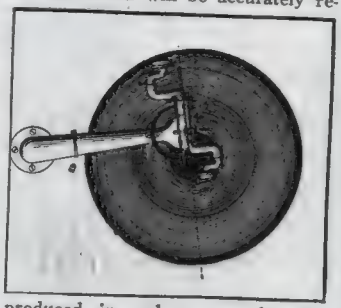
This invention relates to a new type electric motor whereby a regulation as to the speed and power is made by a unique manner. Permanent magnets of the horse-shoe type are mounted upon a frame. In the center part is a series of electro-magnets in an upright position and rotatably mounted in this frame. When current is applied, it enters thru the commutator at the base and energizes the magnets which are so arranged so as to be of alternate polation and cause the motor to rotate by reason of repulsive and attractive effects, between the electro-magnets and the permanent magnets. The latter are mounted upon hinged sections so that the armature can either be approached or receded from, in this way regulating the speed and power.



Repeating Attachment for Talking Machines.

No. 1,339,199, issued to Joseph C. Hitchner.)

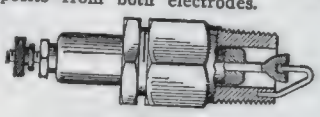
This invention consists of a very novel constructural arrangement of two sound reproducing mechanisms attached to one tone-arm and with tripping apparatus which enables the record to be repeated over and over again. A telescopic sleeve to which each tone-arm is mounted allows for the adjustment of one sound box at the start of the record. The other sound box will be placed at the end of the record. When the right-hand tone-arm has completely traveled toward the end of the record, a set of cams and levers are operated which raise the tone-arm, and simultaneously lowering the one at the opposite end and the record continues to play with the other sound box operating. Upon coming back to the original position, the same effect is reproduced. By careful adjustment of the stabilizer on the machine the last and first notes of the record will be accurately reproduced in order, one after the other, so that there is apparently no break between the end of the song and its beginning. It can be employed with the hill and dale records and also those having a laterally arranged impression or groove.



Spark Plug.

(No. 1,336,914, issued to Harry J. Munster.)

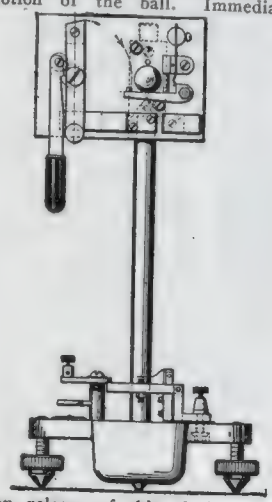
This invention for which a U. S. letters patent has recently been granted has for its principal object, an upper electrode, the terminal of which extends beyond the lower electrode and having a dome-shaped inverted cup arrangement in which a recess is cut. This allows any oil to flow downward without interfering with the spark, at the same time the spark commences in the upper portion of the recess and traveling downward eliminates carbon deposits from both electrodes.



Timing Apparatus.

(No. 1,337,335, issued to Irving B. Smith.)

A very ingenious idea is the subject of a recent patent issued to this Pennsylvanian, which enables accurate analysis of time, either making and breaking a contact or breaking first and making later, in accordance with the binding posts used. It consists of a hammer which is made to rotate rapidly which can be released by a lever-like handle projecting below the upper part of the instrument. In the course of its revolution the hammer strikes upon a pin which releases a metallic ball from a scaffold-like platform. This platform moves away much more rapidly from the descending ball so that it in no way interferes with the downward motion of the ball. Immediately

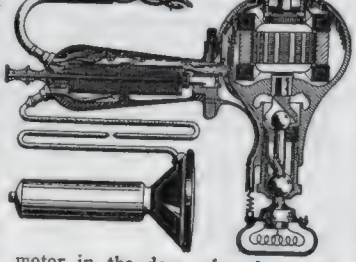


upon release of this platform, contact is made thru an electric circuit or broken just as desired, and when the ball has dropt it again closes the contact thru a tongue-like piece of metal dropping into a trough likewise. This contact at the lower end can be either made or broken in accordance with the binding posts in use and the method desired.

Combination Faradic & Vibratory Massage Implement.

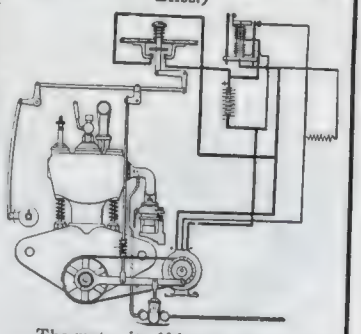
(No. 1,338,020, Issued to Edward Masayoshi Kojima.)

This invention possesses so many novel features, that it promises to be accepted universally as soon as placed on the market. It comprises a vibratory massage apparatus, a means for producing and supplying both heat and light, and also faradic current with the regulations for each. Essentially, it consists of a



motor in the dome shaped portion, into the socket of which is a ball element. This ball actuates the oscillator and can be regulated to give a greater or smaller amount of vibration as desired. A push button in the handle is provided for its operation. The vibrator element itself is an applicator bulb provided with a glass body wherein is embodied the electrode filament which gives both heat and light. The control of the same being obtained thru a set of carbon diaframs or other high resistance discs. The resistance is increased or diminished by varying the pressure upon them. Another set of these discs operates the faradic appliance in regard to increasing or diminishing the current. Both sets of discs are operated by a duplex screw in the handle of the implement.

(No. 1,335,153, issued to William L. Bliss.)

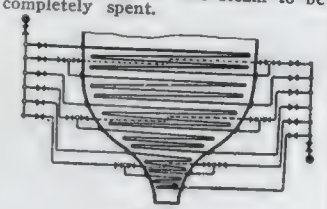


The motor itself has a pulley placed upon its shaft provided with a ratchet like arm acting in this manner as a one-way clutch. Upon the motor another similar ratchet clutch is placed. The shaft is provided at its extremity with an eccentric pulley, and the motor turned over by a ratchet pipe-wrench action. When the gasolene motor is operating as such, it is disengaged from the rocker arm.

Indirect Boiling Apparatus.

(No. 1,337,704, issued to Rolf Harald Hult.)

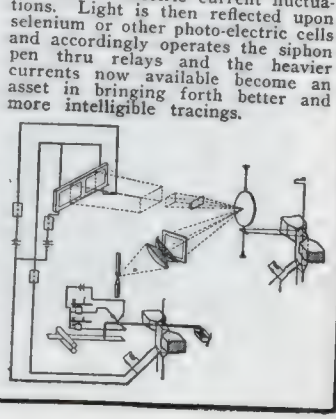
A method whereby steam is conserved in indirect boiling apparata, due to the fact that the pipes can be arranged in either parallel or series; the latter arrangement when the liquid is quite hot. This allows the full energy of the steam to be completely spent.



Telegraphy Amplified.

(No. 1,339,551, issued to Thomas Bullitt-Dixon.)

Heretofore, signals being transmitted across submarine cables have been greatly retarded at the receiving end, and the dots and dashes which are recorded on tape by siphon recorders. The recorders are actuated by sensitive galvanometers which in turn operate the pen, the latter being a siphon tube. The tracing thus produced is a wavy line, on one side of an imaginary center for the dashes and on the other side for the dots. At low speed they are transmitted clearly, but at a higher rate of speed become indistinct. The inventor employs a galvanometer fitted with a mirror. A powerful ray of light is concentrated upon the mirror on the galvanometer. This is caused to oscillate due to electric current fluctuations. Light is then reflected upon selenium or other photo-electric cells and accordingly operates the siphon pen thru relays and the heavier currents now available become an asset in bringing forth better and more intelligible tracings.



Scientific Humor

FIRST PRIZE $3.00

He Could Swim In His Bathing Suit. FIRST OPERATOR TELEGRAPHING—"Can't come down—washout on line."

SECOND OPERATOR, ANSWERING—"Borrow a shirt and come anyway."—*V. J. Sandors.*

Quite So.—TEACHER—"Every day we breathe oxygen. Willie, what do we breathe at night?"

WILLIE—"*Nit*rogen."—*Frank Simpson.*

So That's His "Attraction."—"They say that Paderewski has fascinating manners."

"Yeah, one of those *magnetic Poles,* I s'pose."—*Frank Simpson.*

Some Thinkers Resemble Cuckoos!—When does a hen resemble a thinker?

When she is in earnest.—*Mrs. W. E. Claycomb.*

Easy Pickings.—Seeing an Irish laborer pick up an electric cable, an electrician cautioned him not to handle wires because they might carry a high voltage and kill him.

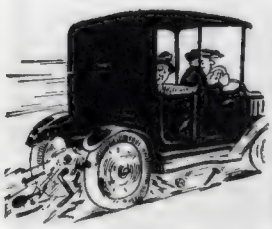
The Irishman replied, "Sure, Oi thought of that, but Oi felt it all over before Oi picked it up!"—*Clarence A. June.*

How Many Revolutions Per Minute?—From an engineering standpoint, Mexico seems to be the greatest country in the world, for there, they get the maximum number of *revolutions* with the minimum amount of *power.—Thomas L. Barker.*

"Within The Law."—SON—"Say, pop, what is Newton's law of gravitation?"

POP—"It is—let's see. Hem! Newton's law of gravitation is—What is it now? (Suddenly relieved) That's a foolish question, son. There's no such thing anymore since Professor Einstein's discovery.

—*Loyd Hutchens.*



A True Genius.—"That man is one of our great inventive geniuses."

"How's that?"

"He magnetizes the rear axle of his Ford so he can pick up the parts as they drop off."—*Leonard E. Himler, Jr.*

The Plate Was "Over-Developed."—WATT—"How was that snapshot of Mabel in her bathing suit?"

KNOT—"Not good."

WATT—"What was the matter?"

KNOT—"Too much exposure."—*Earl Keiser.*

And Both "Charge" You Plenty!—"What is the difference between an electrician and a huckster?"

"One *produces Storage Cells,* and the other *sells Storage Produce.*"—*Geo. M. Harrer.*

An Alarming Situation.—JONES—"Did your Electric Burglar Alarm prove its worth?"

SMITH—"I suppose so. It was stolen the first night I tried it out!"—*L. Snipes.*

Bought It C. O. D. (Current Oozed Down).—IRATE CUSTOMER—"I just bought this battery and I can't get any current out of it."

SALESMAN—"Did you have it charged?"

I. C.—"No, I paid cash for it!"—*V. H. Todd.*

Is This a "Phoney" Patent.—BELL—"I am going to invest some money in the new automatic telephone."

CELL—"What! In such a phoney proposition."—*George Spector.*

No, They "Rubber" Too Much!—SON—"Papa, we get electric current from city electric plants; why is it we cannot get electricity from rubber plants?"

PAPA—"Because they are insulators, my son!"—*H. W. Roces.*

ALL jokes accepted and publisht here are paid for at the rate of one dollar each, besides the first prize of three dollars for the best joke submitted each month. In the event that two people send in the same joke so as to "tie" for the prize, then the sum of three dollars in cash will be paid to each one.

Must Have Been Deli-Kate!

There lived an unhappy lass,
Her tragic name was Kate,
She drank an ounce of water glass,
Oh, wasn't that a *silicate?*

—*J. M. Kindall.*

Of Interest to Ladies.—NERVOUS OLD LADY—"Constable, is it dangerous to put my foot on the trolley car rail?"

P. C. MURPHY—"No, mum; not widout ye put yer other fut on the overhead woire."

—*R. Peaker.*

How Impo-Light.—INQUISITIVE CUSTOMER—"What kind of lights do you use in this store?

"Three kinds, Madam; electric lights, gas lights, and israelites," replied the little Hebrew clerk in his most suave manner.—*J. W. Schoonmaker.*

Wives—Take Notice.—DOCTOR—"You said you were hit with a flatiron. You do seem to be suffering from shock."

PATIENT—"Yes; it was an *electric iron!*"

S. S. Medeiros.

Shake Before Taking!—TOMMY TO AVIATOR—"What is the most deadly poison known?"

AVIATOR—"Aviation Poison."

TOMMY—"How much does it take to kill a person?"

AVIATOR—"One drop!"—*Ronald Merritt.*

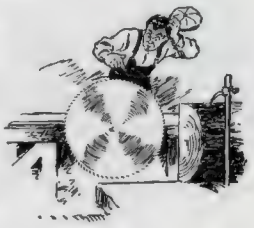
He Never "Misses" Evidently.—SPARK—"How is your boss now?"

PLUG—"He is still firing."—*R. I. Pernell.*

Electric Shops Will Take Notice.—Now that we have prohibition, no doubt we shall have to use only *"dry"* batteries.—

—*John Dowden.*

Convincing.—A sign posted up in a Wisconsin saw mill, reads: "The saws *are* running—no use to touch them to convince yourself."—*A. R. Albro.*



Some Nerve.—DOCTOR—"You are suffering from nerve exhaustion, and I can cure you by electric treatment for the small sum of $200.

PATIENT—"And then will my nerve be as good as yours?"—*Rose Harris.*

He Needs An Electrician.—"I've been reading an article on electricity, William," said his wife, as she laid down the technical magazine, "and it appears that before long we shall get pretty near everything we want by just touching a button."

"It will not pay here!" said friend husband. "You will never be able to get anything that way."

"Why not, William?"

"Because nothing would ever make you touch a button. *Look at my shirt."—Frank Becker.*

Maybe He Needed a Cleaning.—"Mrs. Gadlots is terribly upset over the loss of her pet poodle."

"Yes, it was very sad. After they had hunted for him all day, they found that one of the maids had accidentally pick him up with the vacuum cleaner."—*C. A. Butterworth.*

Not As Advertised.—YOUNG MAN ON TELEPHONE—"Hello, is this the weather bureau? How about that shower tonight?"

WEATHER BUREAU—"Don't ask us. If you need one, take it.—*Henry F. Robbins.*

A "Hot" One.—PROFESSOR—"Name one of the tropics."

PUPIL—"Can't, sir!"

PROFESSOR—"That's right. Tropic of Cancer."—*V. K. French.*

THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

MONEL METAL FOR BOAT HULLS.

(1052) John Smith, New York, N. Y., inquires:

Q. 1. The writer has been much interested in some recent reports on monel metal, and if he recollects correctly, it was used in building a large yacht, the *"Sea Call,"* a 214 foot craft, several years ago, which, soon after it was built, disintegrated. Can you tell me anything about this?

A. 1. You are correct, and the palatial yacht, the *Sea Call,* was built almost entirely of monel metal placed on the hull, below the water line. The idea of the owner and builders in employing monel metal in constructing this boat, was that the well-known resistance of the metal to corrosion would protect against the fouling of the hull by marine growths.

Monel metal, is as you probably know, about 68 per cent nickel and 32 per cent copper, and was invented by Ambrose Monell.

Three months after the yacht had been launched, she was taken from the water and broken up for scrap—the builders and owner having apparently decided that the monel metal had proven a failure owing to the fact that the steel parts of the boat which had been in connection with the monel metal, had been so severely corroded by electro-galvanic action that they were practically destroyed. This is now thought to have been an erroneous conclusion, and that it was not the fault of the monel metal that the vessel disintegrated so quickly, but that the blame for the disintegration of the yacht, should have been placed on the manner of construction and the arrangement of the various metals used.

The action was electrolytic, and the most severe corrosion took place on the thin steel rib which formed the outer frame of the rudder, and also on the steel stem of the vessel. The monel metal plates themselves, showed not the slightest evidence of corrosion in any way, as a report in *Engineering News* at the time, showed.

Before this craft was built of the monel metal plates, extensive experiments were carried on with sensitive electrical meters and various metal plates such as steel, etc., placed in proximity to monel metal plates, but no electrical activity worth mentioning, was noted; it was therefore considered safe to proceed with the building of the vessel.

It is now thought that the engineers were fooled eventually, owing to the fact that the vessel was of entirely different shape and of much larger submerged area than any of the small metal pieces tested in salt water at the ship yard before starting to build the boat; and also because the area of monel metal exposed to the sea water on the hull of the vessel was so very large in comparison to the area of steel exposed, which caused the corrosion of the steel to be concentrated and greatly intensified.

It seems indeed strange that some such action should not have been foreseen in view of the large amount of experience on record as to the effect of galvanic action between steel and some of the copper alloys when immersed in sea water. Monel metal, we are informed, is almost identical with manganese bronze in its electrical relation to steel when connected as a galvanic couple. In ships which use manganese-bronze propellers it has become common practise to attach plates of zinc to the hull. As the zinc is more electro-positive than the steel, the corrosion due to the galvanic action with the manganese-bronze propeller is concentrated upon the zinc and the steel is protected.

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MECHANICAL PHOTOS—
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RADIO PHOTOS—
New stations, both commercial, government, and private. Owners of private or amateur stations will find a special contest for these photos on another page of this issue. And don't send us plate or film "negatives"; send unmounted or mounted "prints" preferably a light and dark one. Enclose stamps if photos are to be returned.

Address photos to—Editor "Odd Photos", Science & Invention, 233 Fulton Street, New York City.

THERMO-ELECTRIC EFFECTS.

(1053) Edward O'Connell, Philadelphia, Pa., writes:

Q. 1. Asking about various thermo-electric effects.

A. 1. So far, it is yet not quite determined as to what really causes the Thermo-electric effect when two dissimilar materials are connected together.

The Thermo-electric series is as follows and any of the materials will be positive toward those after it in the following table:

Bismuth, Nickel, German Silver, Lead Platinum, Copper, Zinc, Iron, Antimony, Tellurium, Selenium.

Powerful Thermo-electric batteries have been made by Clamond, Noe, and others. Such batteries actuated by a large furnace were extremely difficult to maintain in constant operation, owing perhaps to a permanent molecular change at the junctions.

You can purchase these materials from any large chemical supply house.

GOOD TO LEAVE HIGH SCHOOL FOR COLLEGE?

(1054) Harry Batastini, Brookville, Pa., writes:

Q. 1. I am a reader of the ELECTRICAL EXPERIMENTER and needless to say it is a "great" magazine.

The purpose of this letter is to ask advice. I am a student in a local High School and have three more years before I graduate, and I would like to know if it would be advisable for me to drop my High School work and take up a course in electrical engineering in a school in Washington, D. C. Of course, it would be better to finish my High School course and then take up engineering, but that is where the hitch comes in, if I finish my course in High School I am not certain of being able to attend an engineering school for financial reasons, but if I take up engineering now I am sure of seeing my course (in engineering) thru.

A. I. We have carefully considered your query, and to begin with, we would not care to say one way or the other, whether or not it would be preferable for you to continue with your High School work before taking up electrical engineering in the Washington school, as you suggest; or to stop your High School work now and at once take up the electrical engineering course.

Speaking from personal experience and observation, the editor of this column would, he thinks, prefer to give up the High School and at once take up the electrical engineering course, provided you pass the entrance examinations for the latter course.

It might be that you would have to work quite hard or even go so far as to hire a tutor to brush you up a little on mathematics, etc., so that you could take the examinations for entering the electrical engineering course, but under the circumstances which you describe, it would seem a feasible policy to do this. However, it is of course, up to you in the final analysis.

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Johnson's Stop Squeak Oil—penetrates between the spring leaves thoroughly lubricating them. Half-pints—35c in U. S. East of Rockies.

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Johnson's Black-Lac—the perfect top dressing. Easy to apply—dries in fifteen minutes—is permanent, water-proof and inexpensive. Half-pints—75c in U. S. East of Rockies.

Johnson's Cleaner—for body, hood and fenders. Removes stains, road oil, grease and body scratches. ½ lb. cans—45c in U. S. East of Rockies.

Johnson's Prepared Wax Liquid—the dustless automobile polish. Sheds water like a duck's back. Half-pints—50c in U. S. East of Rockies.

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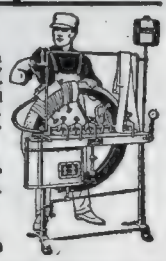

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Man-Made Rubies

By O. IVAN LEE, B. Sc.

(*Continued from page* 359)

periodically taps on this magazine and jars a little powder into the oxygen stream. Beneath the flame of the blow-pipe is fixt an upright rod or candle of incombustible material. At first, the flame is not hot enough to thoroly fuse the oxid but just enough to make it sticky. Consequently, the powder gradually builds up a little cone of rather porous aluminum oxid. When a suitable base has thus been provided, the heat is increased by adjusting the gas supply until the tip of the cone fuses to an incipient head. Now the flame is made yet more intense and it "mushrooms" out and envelops the top of the *pear, boule* or *brut* as it is called. Tiny molten droplets of aluminum oxid brought to the fluid state by their passage thru the fiery zone above spatter on the top of the pear, literally plastered by the force of the blast, and gradually increase its size to almost any that may be desired.

When hot, this *boule* is clear and free from flaws; but on cooling, it cracks down the center by reason of an internal strain similar to that which resides in the well known Prince Rupert drops. Indeed, the early rubies made by this method on a wide base, had a disconcerting habit of breaking into a multitude of particles, but those formed as described on a narrow neck, simply split in two, each half then being used by the cutter.

The aluminum oxid may be prepared from ammonium alum. This is dissolved in water and ammonia added, producing a gelatinous white precipitate of aluminum hydroxid which is washed repeatedly by decantation. On ignition, this substance loses water and becomes pure aluminum oxid which is ground and sifted. In practise, the materials used must be of great purity for the merest trace of certain substances will ruin the color and transparency of the gems, the white saffire being particularly sensitive.

If it is desired to make a ruby red, a very small percentage of chromic oxid is introduced by mixing a bit of chrome alum (those violet crystals which deposit in old bichromate plunge batteries) with the ammonium alum solution. If a blue saffire is wanted, a little iron and titanium in the correct proportion will duplicate the color of transparent blue corundum exactly, and other tints and colors may be produced by adding traces of other metals. Incidentally, it is interesting to note that it took a year of very patient, painstaking and expensive research to find out *just what makes a saffire blue!*

Since the raw materials are very cheap, labor and overhead are the chief items of expense in a "Ruby Factory." The cutting, too, requires great skill and experience, but notwithstanding, genuine synthetic rubies may be had *for less than ten dollars a carat.*

SYNTHETIC RUBY AT $10.00 A CARAT—RIVALS NATURAL STONE.

So far as the physical and chemical properties go, synthetic rubies are identical in every respect with the gems obtained from mines. They are as much alike as artificial (synthetic) ice and that taken from frozen ponds. They are composed of the same material, owe their colors to the same impurities, are of equal hardness, and have the same optical properties, such as refraction. Under a high-power microscope, however, the minute flaws of a natural ruby are seen to have flat sides, while those of the synthetic stone are rounded; also, the flaws of the mined stone are arranged in parallel plane layers, those of the synthetic stone lie along slightly curved layers like those of an onion. These differences are very slight and cannot be infallibly detected even by experts, so that practically speaking, the differences between the product wrought thru eons of time in the underground laboratory of Dame Nature and that evolved in a few minutes by the skill of the chemist, are negligible. It is only a question of decades when he will also manufacture diamonds commercially. He has already produced minute ones, but like the first synthetic rubies, they were useless to the lapidary. One wonders, tho, if the discoverer of a feasible process will possess a dangerous secret; and if people will prize diamonds so highly *when they are retailing for five dollars a carat!*

Book Review.

SCHOOL OF PRACTICAL ELECTRICITY—BOOK I. Fundamentals of Electricity and Wiring. Fully illustrated. Cloth covers, size 7 by 10 inches. Publisht by School of Engineering of Milwaukee, Milwaukee, Wis.

Of recognized aid in the teaching of the fundamentals of electricity and wiring is Book I of the text book series "School of Practical Electricity." Written by Oscar Werwath, E.E. President of the School of Engineering of Milwaukee in collaboration with several members of the faculty of that school.

Dry technicalities are avoided but the subject matter is presented in an interesting way that permits the student to firmly grip and retain what he reads.

Profusely illustrated not only with diagrams but interesting halftones, the book contains in the short space of 60 pages all the essentials and fundamental principles of electricity.

Installation of bells and annunciators with their respective circuits, the telegraph system and the use of various codes, sources of current and the types of connections and circuits, as well as the historical aspect of electricity are logically and exhaustively treated. The telephone system is thoroly explained covering the elements of the telephone set, such as transmitter, hook and receiver, and many laboratory experiments are given. Of much importance to the practising electrician as well as to the electrical student are the definitions of electrical terms, examples of estimates and contracts and a series of "don'ts" to be observed in installations of all kinds. The contents of the tool kit and points on electrical workmanship are also described. As a manual for the electrical laboratory the book is also of value on account of the wide variety of experiments outlined.

DYKE'S AUTOMOBILE ENCYCLOPEDIA. By A. L. Dyke, E.E. Tenth edition. 960 pages, 3,362 illustrations, 6,000 lines of index. Publisht by the author, St. Louis, Mo.

This remarkable book has again been revised and greatly improved. It could appropriately be termed a "Repairman's Guide." In addition to its mass of information on automobiles, covering every detail from the construction and repair of the axle to the repair of radiator and top, many new subjects have been added. For instance, how to make electric tests of the starting motor, generator, battery, coils, magnetos, etc. In fact, the subjects are dealt with in such a simplified manner that one can almost understand by a mere glance at the numerous illustrations.

The storage battery subject is profusely illustrated, and anyone who can read plain English can soon learn how to diagnose trouble, disassemble, repair, assemble and recharge batteries. A feature of this instruction is a simplified explanation of the "Cadmium Test" of a storage battery. One naturally thinks of a very technical and complicated subject, but after reading this subject and a glance at the numerous illustrations the 'tech" part becomes perfectly clear.

The tire subject is very interesting. One learns the difference between the "molded" tire and "wrapped tread" tire. The difference between the "fabric" tire and the "cord" tire and the advantage and disadvantage of each. Such subjects as blow-outs, stone bruises, loose treads, etc., are thoroly treated with an explanation of the cause and how to repair.

Water--The Elixir of Life

By WILLIAM M. BUTTERFIELD

(*Continued from page* 370)

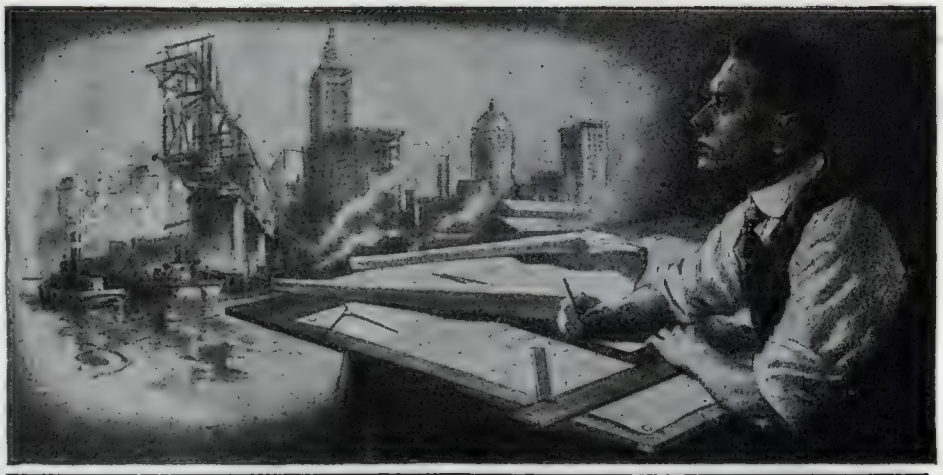
is made possible by the amount of moisture each has absorbed from the air. The average percentage of water in animals—man included—is about 80, and in vegetables over 90, thus giving a very large predominance of the liquid over what is known as the body or solid part.

The atmosphere, or air a man breathes, is also saturated with water in variable degrees, the dryest being composed of 4/10,000 part of this fluid. It is for this reason that no object exposed to the air is entirely free from it. The stick he carries, his hat, gloves, tie, handkerchief, shoes and clothing are liberally irrigated. Every conceivable thing that surrounds him at home or in his office; even his watch, scarf-pin, ring, quarters and half-dollars are saturated with water as surely as his body. Geologists tell us it forms ¾ of the earth's surface in the form of oceans, lakes and rivers; forms 1/3 of the soil, and penetrates into every crevice and invisible opening in the rocks and minerals. We see, after a little consideration, that water is a very vital substance to man, to the vegetable and animal kingdoms and to the world they live upon.

It is not vital because it forms nearly 80 per cent. of the materials on the earth's surface, but really because it alone makes possible that unknown something called "Life." First, water in some one of its three forms (solid, liquid or gaseous) makes the blue in our atmosphere, the clouds, fog, dew, rain, snow and ice. Deposited in the form of rain, snow or ice at the tops of lofty mountains, it causes by its presence extreme contraction in the rocks, thus causing them to break into particles, many of which, each time this breaking action is repeated, are seized to be quickly pushed or carried away by the water, as it forms into streams and rivers, to the lakes or oceans. Here the particles are subjected to the action of the waves and ultimately rounded into boulders, gravel, sand and finally into the kind of particles that form the soil. The enormous quantities of water upon the earth undergoing changes of this nature cause an increase or a lowering of temperature, thus expanding or contracting the atmosphere. This action produces the winds which in time operate the waves. In fact, water is wholly responsible for those changing conditions which we call "weather."

Water never occurs absolutely pure, for it is our most efficient solvent and contains in solution, more or less of the constituents of the strata thru which it has past. For instance, rain water, the purest known natural water, after passing thru the atmosphere contains such substances as ammonia, nitrate of ammonia, carbonic acid, and nitrous and sulfurous acids. Spring water, or that from hydrants, always contains a larger percentage of dissolved substances than rain water.

Water is the common carrier of Creation. It dissolves the elements of the soil, and, laden with them, climbs as sap thru the cells and capillaries of every individual plant, thus conveying the substances of rivers, lakes, and oceans. It also forms one-third of the soil; fills to some extent every opening and tiny crevice in the rocks and minerals; it occurs in combination with many mineral substances; forms from 80 to 90 per cent. of all organic bodies, such as animals and plants; and is the most efficient of all solvents, few substances not being to some extent affected by it. It is because of this that it never occurs absolutely pure, but contains in solution, more or less of the constituents of the strata thru which it has past.



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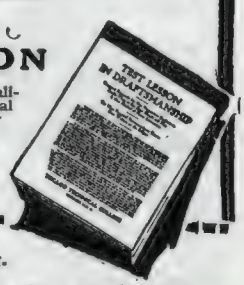

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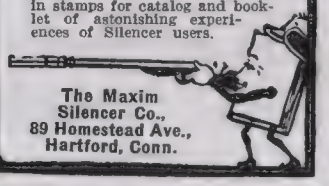

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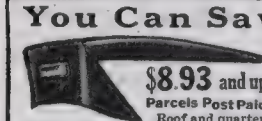

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In the human body, water flows as blood or other fluids to every part of the system, also building or repairing with its solutions the "house we live in." It changes the common air that we breathe, and in its way tempers the gases of the atmosphere to our needs, whereas these gases without it would destroy us.

It is because of these combinations and their chemical action that men exhale carbonic anhydride in breathing, an animal-made gas when mixed with the atmosphere absolutely necessary to the growth and life of plants. While, on the other hand, the plants are caused by similar chemical action to throw off oxygen, without which man or any other animal, would cease to live. Water, therefore, is the medium that conveys the solid parts, in the form of solutions to one plant and animal; causes these solutions to combine and harden thru laws that are common with dissolved substances; and aids the living organism to function by aid of these natural chemical changes.

When spring water is highly charged with saline or gaseous constituents, so as to have a peculiar taste or smell, it is called mineral-water. Whether these mineral solutions are formed by natural or artificial means, they are said to have beneficial or harmful properties if used as beverages. For this reason the resorts we have named, and many natural or artificial waters are made profitable investments, the desire of mankind to obtain a "water-cure" never at any time ceasing. The fountain of youth is supposed to be a kind of supreme, or shall we call it "super-natural" water-cure. Yet it is a dangerous experiment to drink any of these super-charged waters, unless they have proven beneficial as a common beverage to large numbers of people for long periods of time, advertisements and doctors' prescriptions to the contrary notwithstanding.

As an illustration, sea-water is essentially a mineral-water and contains in solution almost every mineral substance; its saline constituents in the free ocean is about one ounce to the pound, and it is probably slowly increasing thru evaporation, yet innumerable forms of plant and animal life thrive in and upon it. Fresh water plants and animals, of which man is one, cannot exist if compelled to use it in their bodies. If it becomes charged to one-third or more of its whole weight, with saline matter, like the great Salt Lake in Utah, it becomes impossible for even the sea-water forms to live in it. On a large scale, this shows the harmful results to organic life when water not suited to each individual's requirement is used.

The real fountain of youth is found in any locality where its drinking water agrees with the physical requirements of its population as a whole. The water supply of the City of New York is likely to perform more miracles of rejuvenation and health building, if properly used, than all the health resorts or patent mineral-water concoctions imbibed while taking a "cure." The way to obtain lasting and invigorating results at this time is to exercise and feed the body in such a manner as to supply the necessary natural stimulas for a proper circulation thru the system; then, if the water contains the constituents required, perfect results will be obtained.

First Electric Welded Building

By H. B. PAYNE

(*Continued from page* 362)

The trusses were left under load forty-eight hours and readings taken showed—East support settled 15/16 inch, west support, ¾ inch, actual. Two days afterward the load was entirely removed and readings taken at this time showed all points in the trusses had returned to their original position, leaving no permanent deflection except at point No. 3 of 1/16 inch. To quote from the official report:

"From the above it is evident that electric welding is a dependable method of uniting structural members *and is stiffer than riveting, if the work is properly performed.*"

It is particularly interesting to note that this test was actually carried to the limit of elasticity of the metal used. There is no doubt that this successful demonstration will do much to further the use of electric welding in steel construction work. The many specific advantages are too important to be disregarded by engineers and contractors, particularly in these days when there is a vital demand for increased housing facilities for homes as well as for industries. It would seem almost axiomatic to say that electric arc welding is going to make substantial progress in displacing riveting in the structural steel field.

The mere fact that this test was witnest by members for all building departments in Greater New York, and as a result a permit was issued for the erection of the building, the first of its kind, should be sufficiently convincing to the skeptical, that electric welding as a means of construction is not an unknown quantity but is a certainty.

Generally speaking, electric welding can be used in all parts of steel structures. Electric welding eliminates the use of bolts, rivets and gusset plates, and in some cases connection angles and brackets.

ELECTRIC WELDING CHEAPER THAN RIVETING

Comparative figures for an estimated construction cost of a steel barge measuring 166 feet in length by 39 feet in width, by 8 feet 8 inches in depth, were made recently. The figures were based on 1917 wage rates and material prices, but of course approximately the same *ratio* between riveting and electric welding of such vessels would hold with the present labor and material prices, altho these are higher.

Figuring on the construction of the above-size steel barges, we find that for a total production cost of about $11,500 for the riveted and welded types, that with the *electric welded* type there is shown a profit of nearly $2,000, or to be exact—$1,838. On this construction cost of $11,500 there is no profit left with the riveted design. The riveted design is much more expensive, almost double in some instances, when it comes to the various details of the construction work, such as, for example, the erection and assembling—this item amounting to nearly twice as much for the riveted design as for the electrically welded barge. The chipping and caulking amounts to twice as much for the riveted design as for the electrically welded barge. The item of rivets costs $780 alone, while the punching and shearing costs amount to twice as much for the riveted design as for the electrically welded type.

In other words, unbelievable as it may seem to those familiar with the regular riveted steel structures, on this particular job—amounting to $11,500 on an estimated budget—you can have your choice of *riveting* the ship with *no* profit; or *electrically welding* it and having a profit of nearly $2,000, or 16 per cent.

Popular Astronomy

By ISABEL M. LEWIS, M.A.

(*Continued from page* 391)

the ruling sun, the secondary sun would be visible at one time by day and again by night. If, as is frequently the case, the two suns are of contrasting hues, as, for instance, green and red, there might appear in the nearby heavens at a distance of one hundred million miles or so a magnificent sun of deep reddish hue, equal to or surpassing our own in splendor, while in a far distant part of the sky, at a distance as great as lies between us and the planet Saturn, might appear a rival sun of greenish hue, smaller and fainter, but nevertheless, hot and brilliant and capable of exerting thru its great gravitational power a most disturbing effect upon the motion of the planet of its neighbor. At times the rays of the two suns, *red and green,* would combine to produce a day characterized by terrific heat and intense illumination. Again the green orb would rise in the east as the red sun set in the west and night would be turned into a weird, dimly-lighted day by the greenish rays of the secondary sun. Compared to the wonders and beauties of the heavens in such a system, our own well-regulated and orderly planet family, undisturbed by the exciting proximity of a rival sun, might seem to pale into insignificance. Yet we have every good reason to be content with the ordering of affairs within our own solar system, and to feel relief rather than regret at the absence of a secondary sun. In a planet world revolving about one member of a double star system, we can well imagine the dread rather than pleasure with which the periodic near-approach of a rival sun would be hailed, and even the possible hurried migration from exposed to sheltered portions of the planetary world to escape the rapidly increasing heat and intensity of light from the approaching sun. In such systems of suns the coming and going of the seasons might well be a matter of life and death to the inhabitants of satellite worlds, while to keep track of the perturbations and tidal disturbances produced by the nearness of such a powerfully attractive mass as a secondary sun, would drive the astronomers of such a planet world to distraction, unless they were more successful than ourselves in mastering the intricacies of that most distressing mathematical problem of the motion of three bodies that still evades the skill of the greatest mathematicians of our own world.

Within our solar system the masses of the planets are practically negligible compared to the mass of the sun, and it is for this reason that they appear to revolve about the *center* of the sun. As a matter of fact, no body in the universe revolves about the *exact geometrical center* of another body, but two mutually attracting bodies revolve in orbits about their common center of gravity, which always lies between the two bodies on the line connecting them and at a distance from each of them that is in inverse proportion to the mass of the body. The moon does not revolve about the *center of the earth,* but about the *center of gravity* of the earth and moon, which lies on the line connecting the two bodies and at a distance from the earth's center that is one eighty-first of the distance from the center of the earth to the center of the moon, as this represents the ratio of the masses of the two bodies. The center of gravity of the earth and moon, therefore, lies about two thousand miles from the earth's center, and about this point both

What Is a Bar-Bell?

A bar-bell is simply a long handled dumb-bell, and is used for developing exercises. It can be made light enough to suit the needs of any beginner, and heavy enough to provide exercise for the strongest men. It is intended for home exercising, and can be used in your bedroom, no matter how small it is.

To be of any advantage, a bar-bell must be adjustable, in order that you may begin exercising with a moderate weight, and gradually increase that weight as your strength increases. Used in connection with kettle bells and dumb-bells, it is the most efficient exercising apparatus ever devised, and produces real health and strength in a remarkably short time. The bar-bell is used by men in every walk of life as a means of keeping in good health, and it has developed all the professional strong men of the country.

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Why is it that the man who exercises with bar-bells can perform feats of strength far bevond the combined power of two or three ordinary men? Not alone because his arms are twice as strong, but because his back, hips and legs are four to five times as strong as those of the average man who uses a system of light exercise. Just having strong arms will not keep you in perfect health. You must be strong in all parts of the body.

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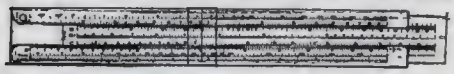

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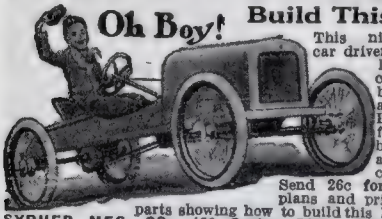

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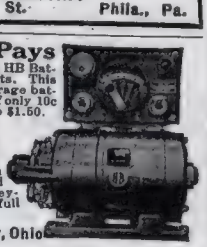

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earth and moon perform orbits of revolution that are identical in form and differ only in size. In the same way each of the planets of the solar system revolves about the center of gravity of itself and the sun, but the mass of the sun is so far in excess of the combined masses of all the planets that we may consider, for all practical purposes, that the planets revolve about the sun's center, the center of gravity of the system being *within the* sun.

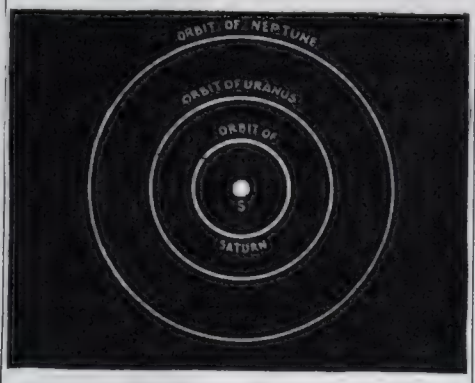

Fig. 1. Plan of Solar System. The Inner Circle Represents the Orbit of Saturn About the Sun, S. The Next Circle Is the Orbit of Uranus and the Outer Circle the Orbit of Neptune. The Orbit of the Earth on this Scale Is About the Size of the Solid Circle S at the Center. The Distances of the Planets from the Sun In Terms of the Astronomical Unit (93,000,000 Miles Distance of Earth from Sun) Are Mercury 0.4, Venus 0.7, Earth 1.0, Mars 1.5, Jupiter 5.2, Saturn 9.5, Uranus 19.2, Neptune 30.1.

Prof. T. J. J. See found from the investigation of forty binary star orbits that the average eccentricity of double star orbits is twelve times as great as the average eccentricity of a planetary orbit, and that the masses of the component suns are always comparable to each other in size. The center of gravity of a binary system, therefore, lies at a great distance from the centers of the stars, and about this point, as a focus, the stars move in orbits that are exactly similar in form but differ in size in inverse proportion to the ratio of the masses. Since the orbits of binaries are, moreover, very highly eccentric, the two suns are anywhere from two to nineteen times nearer to each other at periastron, than they are at "apastron."

We have spoken so far only of systems of *two* associated suns, but many systems exist in which three or more sun-like

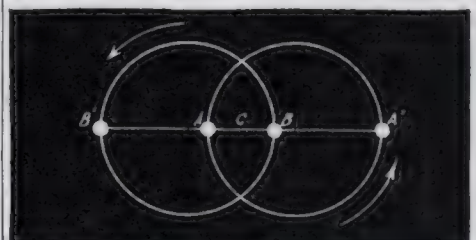

Fig. 2. Here the Distance AB=930,000,000 Miles (Ten Times Distance of the Earth From the Sun). Plan of the Double Star Systems—Alpha Centauri. The Two Suns That Belong to This System Are the Nearest of All Stars to the Solar System. They Are Nearly Equal In Mass, Tho One Emits Only One-Third As Much Light As the Other, and Is a Much Deeper Yellow In Color. The Brighter Star Is Almost an Exact Duplicate of Our Own Sun In Every Way. The Combined Mass of the Two Stars Is Twice That of the Sun. They Revolve About Their Common Center of Gravity at C, In a Period of Eighty Years. As they Are Equally Massive the Center of Gravity Always Lies Just Half Way Between Them and They Are Always at Opposite Extremities of a Straight Line Passing Thru the Center of Gravity. At Periastron They Are Separated by the Distance AB Which Is, As In the Sirian System, About Ten Times the Distance of the Earth From the Sun. Their Distance at Apastron When They Are In the Position A'B' Is Three Times Greater Than When They Are at Periastron.

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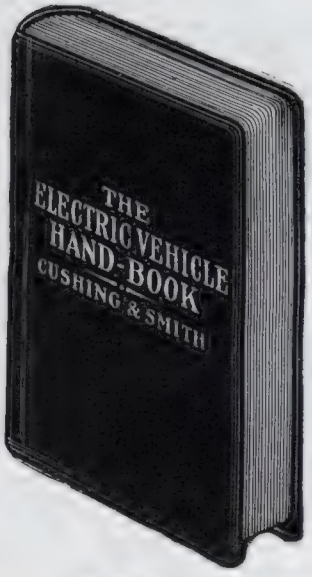

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bodies are in revolution about a common center of gravity. Frequently two fairly close suns are in revolution about a common center of gravity, in a period, say, of fifty or sixty years, while a third sun revolves at a comparatively great distance about the center of gravity of itself and the first pair in a period of several hundred years. Or possibly the third sun also possesses a close attendant and the two pairs revolve in a period of great duration about a common center of gravity.

Such are the systems of *Zeta Cancri* and *Epsilon Lyrae.* In the former system the closer components revolve rapidly in a period of about sixty years, while the remote companion shows irregularities in its motion that appear to indicate that it is revolving about a dark body in a period of seventeen and a half years, while the two together are revolving very slowly in a period of six or seven centuries, about the center of gravity of the first pair in a retrograde direction.

The wider pair of *Epsilon Lyrae* is a naked-eye double for it can be seen as a double star by a keen eye, while even a three-inch telescope will separate each of the components into a double star. So extensive is this system that the periods of revolution of the closer components occupy several centuries, one pair appearing to revolve about twice as rapidly as the other, while the period of revolution of the two pairs about a common center is probably a matter of thousands of years. The gap that separates the two pairs may be so great that light would require months or possibly several years to cross it.

These multiple systems are by no means exceptional. They are to be found in profusion among the brilliant *Orion* stars. They have been referred to as "knots" of stars and it has been suggested that they may have originated as local condensations in one vast nebulous tract. A system of only two components appears to be the exception rather than the rule, groups of several connected suns being more numerous than single pairs.

In all of these double and multiple systems there exists the possibility of minute satellites, such as our own Earth, in attendance upon some component of the system, tho these tiny bodies shining only by reflected light from a nearby brilliant sun would be hopelessly invisible in the most powerful telescope.

We can only assume that it is far more reasonable to believe in than to disprove the existence of such satellites.

Our own solar system, we may say, then, represents neither in its mechanical nor physical features, the only possibilities for the maintenance of life; neither can it be considered a unique form, nor the most generally prevalent form in the universe.

Jules Verne — The World's Greatest Prophet

By CHARLES I. HORNE, Ph.D.

(*Continued from page* 368)

the Probable, indeed in the light of his success we might almost call it the Inevitable. The sureness with which time is accomplishing each serious prophecy of Verne, tempts us to look with even greater confidence to the completion of such of his visions as still belong to the future.

In other words, Verne is not wholly a past issue. The man of today may still read his books with something of that tingling eagerness to go forth and attempt their marvels which inspired readers of fifty years ago. How much, I wonder, of the scientific progress of today do we really owe to Verne? Our country can almost claim him as more American than French. Where and when shall we erect to him a fitting monument?

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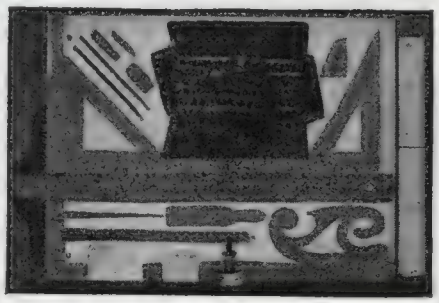

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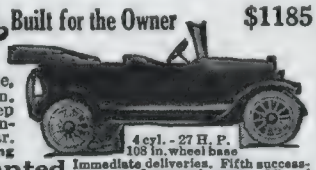

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Marvels of the Ear

By JOSEPH H. KRAUS.

(*Continued from page 365*)

We now must take into consideration the multiplying factor due to the two membranes. Inasmuch as the ear drum or tympanic membrane is twenty times the size of the oval window membrane upon which it acts, any force applying to the former will be amplified twenty times in the latter, if directly connected just the same as for instance in two pumps, one with an area of twenty units and another with an area of one unit. We naturally get an amplification factor of twenty. The lever systems of bones again amplify this one and a half times, but reduce the motion. As a result we find that a movement of the drum is accompanied by a similar movement of the oval window but increased in force fully thirty times.

Communicating with the middle ear is a tube connecting to the mouth which opens upon swallowing. This serves a very important function in allowing the ear to maintain the same pressure on both sides of the tympanic membrane. This function, if destroyed thru disease of the tube, will cause partial deafness because this chamber will have its air absorbed on the inner side, causing extreme pressure from the outside. The bones will then press the oval window inward to a greater extent.

THE "END ORGANS" OF HEARING.

We now come to the end organs of the ear which are the most important of all. Here we have a vestibule to which are added several important structures. Three of these are the *semi-circular canals*, which have to do the work of notifying our brain when our body is right side up. The other important structure which we will now look into is the *cochlea*. This consists of two portions, a bony part which is shell-like in appearance, winding upward in a spiral direction to an apex. This is divided internally into three portions. Two of them bony, more or less, and a third membranous. These partitions can be clearly seen in the accompanying drawing where it will be noted that one lies below the other with the intermediate membranous chamber laterally and seemingly split between the other two.

The *oval window* which we have described before and the membrane covering which is actuated by the last of the bony lever system in the middle ear communicates directly with the upper chamber. All three chambers are filled with a liquid called *perilymph*. The latter fills two chambers, the upper and the lower, while another liquid, *endolymph*, fills the membranous lateral chamber. When, therefore, a vibration causes the oval window to be forced inward, the liquid is immediately comprest in the upper chamber (vestibular). This pressure wave passes along to the top of the cochlea, where the chamber communicates with the lower or tympanic chamber, and the pressure wave passes downward to the end of the lower chamber (tympanic), where the wave terminates at another window called the *round window* because of its shape. Here a bulging of the window membrane can clearly be seen whenever pressure is applied to the oval window.

During the course of the pressure wave, however, it has past along on two long thin sheaves of tissue which encircle the *membranous scala*, causing these membranes to approach each other due to external pressure. Naturally, compression is going to take place in this closed spiral which has no exit except thru a small tube leading into a sack, and in this way acting as a safety valve for pressures which may be

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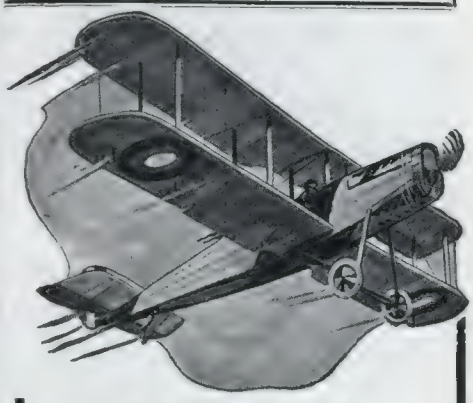

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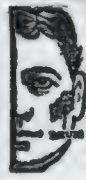

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too great. This *scala* has two membranes, as can be seen from the illustration, causing it to assume a triangular shape. The one on the bottom is called the *basal membrane* or basilar membrane.

This membrane is built like a harp made up of a large number of strings, and it is believed that the vibration of these strings cause the end organs of the auditory nerves, which are mounted upon them, to vibrate and by thus being stimulated, the sense of some distinct sound is immediately transmitted to the auditory centers (cells) of the brain. The basal membrane is widest at the top and narrowest at the bottom and contains 24,000 fibers. Upon these fibers are mounted the end organs of hearing which are small cell-like structures having numerous hairs at the top. Stretching over these is a sort of *soft pedal* arrangement, which in the event of the cells vibrating too much comes down and dampens their action. The auditory nerve itself has 14,000 terminal fibers.

The action in the ear, therefore, appears to be as follows: A sound is transmitted from some position causing a wave disturbance in the air. This disturbance impinges on the drum causing the drum to vibrate, which in turn communicates its vibrations to the oval window, after amplifying them thirty times thru the intermediary of the bones, altho the motion itself is considerably decreased. This pumps a liquid up to the top of the shell-like structure in one compartment and down the other to the bottom again, causing a pressure effect all along the length, but not a flow. This pressure is felt in a flexible chamber, also containing a liquid and having a membrane of strings capable of vibrating. On each string is a specially sensitized cell which, if stimulated, will communicate with the brain, giving indication of sound.

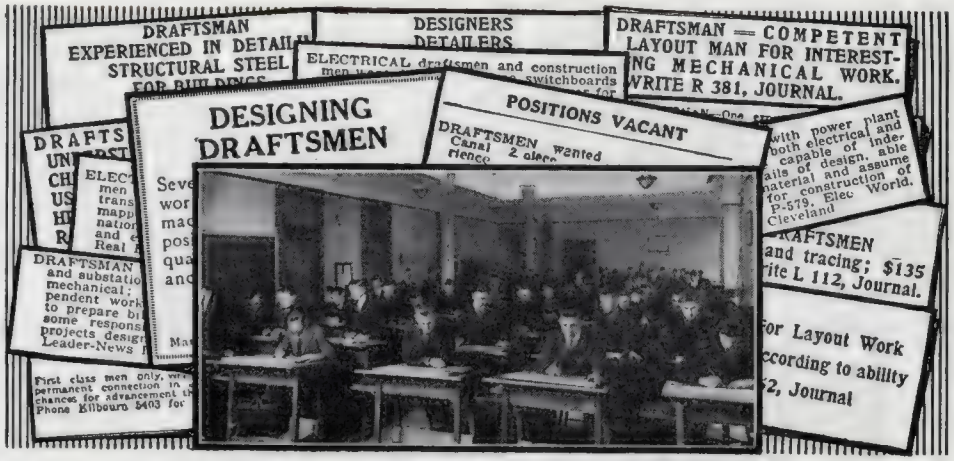
A good musician can distinguish between two notes, one sixty-fourth of a semitone apart. This means that there is more than one fiber, but less than two of the nerve for each note in the auditory scale. The basilar membrane itself has more than two fibers, but less than three for each note, and the peculiar rod-shaped structures, which are shown in the diagram, are more than one in number for each note.

It has been found that in diseases involving the basilar membrane, that the membrane destroyed at the apex or the wider portion of the membrane, means the complete loss of perception of the sounds low in the musical scale, while those destroyed at the base or narrow portion of the membranous scale destroyed the ability to realize the high notes in the musical scale. In birds, altho the distinction between the notes is much more delicate, the scale is greatly limited. The *telephone theory* is different from the above, which is called the *piano theory* of hearing.

THE TELEPHONE THEORY OF HEARING.

This theory relegates the whole work of analysis to the central nervous system to the brain, but gives us no clue as to how such an act of analysis may take place. The idea advanced is that when a bow of a violin is drawn across a plate which has previously been sprinkled with some fine powder such as lycopodium, the plate assumes a complicated pattern having nodal points. It is thought that perhaps the entire basilar membrane vibrates as a whole, but various nodal points will not vibrate as much as the internodal points, and since the hair cells vibrate, with the membrane, and are affected by the dampening membrane on top, a pressure pattern is formed, which pattern is communicated to the brain.

Animal experiments have not completely borne out this theory. Animals such as guinea pigs, etc., have been subjected to a stress of one continuous sound from a pipe organ. The animal when killed, has shown that one certain or definite portion of the basilar membrane, together with the rod cells, has practically disintegrated.



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Electrocuting Sharks

By H. GERNSBACK

(*Continued from page* 364)

The cable itself may be sealed into the bamboo pole by means of a high grade insulating compound. A sort of switch now becomes necessary to turn on and turn off the current for reasons mentioned above. If no such switch were used, it would never be possible to bring the pole with its live point anywhere near the shark, for he would feel the effects of the current several feet away, and would swim out of the danger zone. So a sort of telescopic switch as shown in our third illustration is used, and this may be made to work automatically. In other words, as soon as the pole point is stuck into the shark, the force of the thrust will close the telescopic switch automatically, as can be readily seen. Instantly the current shoots into the shark's body, electrocuting him, providing there is a good contact.

It is however, not always necessary to electrocute the shark, and indeed it is not absolutely necessary. In order to protect the pearl or sponge divers, two or three men armed with electrified poles can take stations around the working divers, while the latter work on unmolested. If a shark comes within sight, the electrified poles will readily ward off the pest, altho it may never be necessary to actually stab him. In other words, the effect of the current will be sufficient to frighten off the sharks should they come anywhere near the electrified zone.

Practical Chemical Experiments

By PROF. FLOYD L. DARROW

(*Continued from page* 393)

ance of the cell, decrease its voltage and therefore its current. There are a number of ways to diminish this action but the following one is a very effective one, and it is not found in the text-books on the subject:

In a fruit jar make up a strong solution of sal-ammoniac. From an old dry cell remove the carbon and secure a zinc rod or heavy strip of zinc. Now immerse the carbon in a dilute solution of nitric acid. Then heat it in the oxidizing flame of a Bunsen burner. Repeat this a number of times after which place the carbon and zinc in the jar of sal-ammoniac. You will find that this cell, unlike the ordinary sal-ammoniac cell, will give a strong current for a long time and when it does begin to polarize give the carbon the same treatment again. Of course fresh sal-ammoniac must be added from time to time.

Local Action: The chemistry of local action is a much more important matter than is commonly supposed. By local action is meant the wasting away of the zinc on both open and closed circuit owing to the presence of little particles of impurity, chiefly carbon. When these impurities are present little batteries are set up between them and adjacent particles of zinc and a vigorous chemical action results, accompanied by the solution of the zinc, the wasting of the acid and the liberation of large quantities of hydrogen gas.

In a tumbler of dilute sulfuric acid place a strip of ordinary sheet zinc and you will immediately observe a myriad of bubbles rising about it. These are due to local action. Remove the strip and dip the end of it in a little mercury. Rub the mercury and it will quickly spread over the entire surface. Now put it in the tumbler of acid and no bubbles will appear. You have covered up the particles of carbon and the tiny electric cells have disappeared. A strip of chemically pure zinc will also show no signs of local action.

One important application of this action is in the generation of hydrogen. Perhaps, sometime you have been absolutely unable to make your hydrogen generator work. Its failure to act *is due to the use of too pure zinc.* Unless there are impurities present to set up little cells the zinc will not go into solution. If, however, you will add 2 or 3 cc. of a solution of copper sulfate an immediate and vigorous action will begin. The zinc drives the copper from the copper sulfate solution and the tiny particles of it collect over the surface of the zinc and at once the electrolytic action and the consequent liberation of hydrogen begin.

Cleaning Silver-Ware: One very unique and useful application of local action is to be found in a new method of cleaning silver-ware. The silver is placed in an *aluminum* kettle or pan and a solution containing 5 teaspoonfuls of baking soda (sodium bicarbonate) to a gallon of water is poured on it. Or the solution may be prepared first in the kettle and the silver immersed in it. Then place the kettle on the stove and heat it nearly to boiling. The soda forms a mildly alkaline solution which will attack the aluminum but not the silver. We have then the exact conditions for an *electric cell* with the result that the hydrogen liberated by the action of the alkali on the aluminum is driven over to the silver where it unites with the sulfur on the latter and quickly removes it. The silver can then be polished with a chamois skin. The amount of aluminum going into solution is not great enough to injure the vessel.

An interesting illustration of local action was recently observed on a splendid new yacht built for salt water. Copper sheeting was put together with rivets containing iron. As a result local action set in and the sheeting quickly fell apart.

One of the most important applications of the electric current is to be found in the electrolytic refining of copper, electroplating and the electrolytic analysis of alloys. The principle of all of these processes, however, is exactly the same as that of electrotyping. Had it not been for the necessity of having a very expensive platinum dish for the electrolytic determination of copper in brass, I should have been glad to describe the practical method of doing this. Silver plating was described in considerable detail by the writer in the *January* issue of the ELECTRICAL EXPERIMENTER.

In addition to these processes there is a host of chemical industries that employ the electric current and are made possible by it. Among these are the extraction of aluminum, the separation of the alkali metals, the preparation of the caustic alkalis, the production of hydrogen, oxygen and chlorine, the metallurgy of steel, the making of nitric acid from the air and many more.

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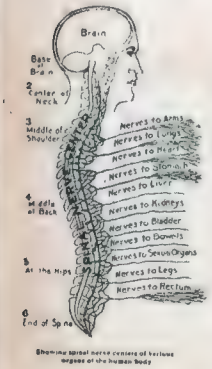

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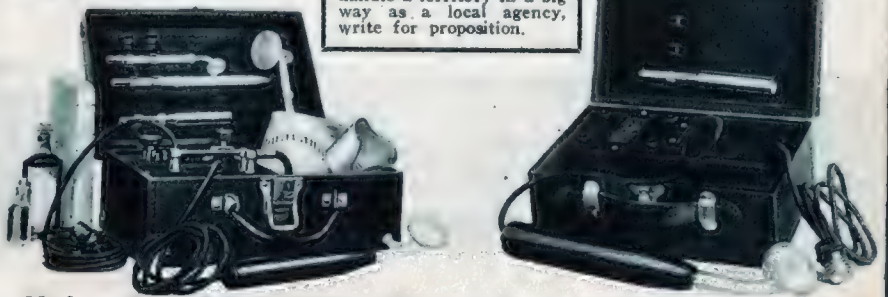

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Movies of the Unseen

By JEROME LACKENBRUCH

(*Continued from page* 361)

ground is used for several pictures and consequently time is saved in making the drawings, as the entire hook-up need only be drawn once. Lines that are to appear in another drawing are never repeated. Only when the action to be shown necessitates a change in part of the drawing is a new plate or background used. In diagram 3, it will be seen that a celluloid composition plate has been superimposed over the background, *and the current is seen to be flowing.* This particular plate shows only the lines represented by the white and black dashes. But when they are placed on top of the background, they fit perfectly into place and are so photographed. This is the action that is evident to the eye. But behind this we know that an electro-magnetic field has been built up and has reached out to include the iron ball and magnetized it so that the end nearest the bar is of different potentiality than the end of the bar to which it is attracted. The theory that unlike poles attract is now flashed on the screen to explain the action; and finally a view of the magnetic field about the iron bar is shown; stage four. Diagram 4, which consists of a background and one plate photographed together, shows the lines of force about the bar that has been magnetized by an electric current being past thru a wire wound about it. Figures 5 and 6, at bottom of strip, show the iron ball attracted partly at first, and then drawn up against the pole. Here we have a fundamental electro-magnet in action.

THE DYNAMO BARES ITS SECRET.

Now that we know the interrelation between magnetism and electricity, the animated drawing proceeds to tell that when magnetic lines of force are cut by a closed loop of wire, an electric current is induced in the wire. The second strip of diagrams show two permanent magnets with magnetic lines of force running from the North pole of one to the South pole of the other. The drawings for this series of animated technical drawings which develop the principle behind the action of an alternating current generator were made by Mr. S. A. Marti of the Bray Studios. The fundamental background for these drawings is an outline of the magnets. The lines of force mentioned above are drawn on a celluloid plate and photographed together with the background.

The next step involves the removal of the lines of force drawing and the substitution of a drawing of an armature (rotating) a loop together with lines of force. This shows the introduction of the simplest form of armature between the magnets. Another drawing shows only the brushes, which connect with the collector rings that draw off the current, when it has been generated by the revolving of the loop in the magnetic field. In other words, diagram 4 is made by photographing together a background, and two plates, one consisting of the loop, collector rings and magnetic field, and the other, of the brushes, the one plate superimposed above the other; and both upon the background.

The electrical action that now takes place is as follows. Assuming that the loop is revolved in the opposite direction of the hands of a clock; that is, up on the side toward the S magnet and down on the side near the one marked N, the current induced will vary in strength during the course of one revolution. If the loop were PARALLEL to the lines of force, there would be no space within the rectangle of the loop circuit to enclose the

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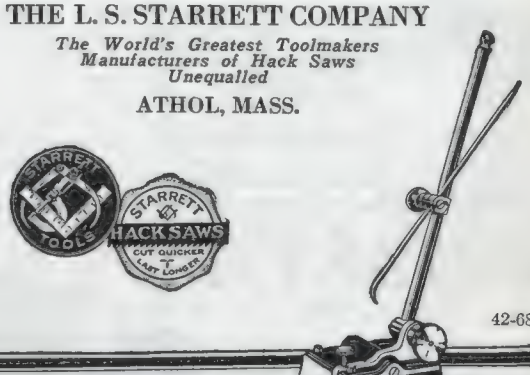

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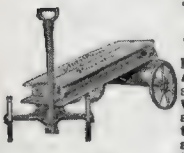

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lines of force passing between the magnets. But, if the rectangular loop were turned to a vertical position with respect to the lines of force, the *maximum* number of lines of force would pass THRU the space enclosed by the loop. Now, by turning the loop (armature), the lines of force are cut; and this cutting results in a current being induced in the loop; forcibly illustrating the basis of action in all dynamos.

It is clear that when the loop is in a vertical position, and it is revolved about its own axis, it will move almost parallel (for an instant) to the lines of force it is cutting. Gradually, however, as the loop moves toward the horizontal position, more and more lines of force are cut at right angles, and consequently an increasingly stronger current is induced in the loop. From the horizontal to the vertical position, the loop cuts fewer and fewer lines of force at right angles until it is again in a position parallel to them. From this we may conclude that as the loop makes one revolution, the current increases as the loop moves from 0 to 90 degrees, decreases from 90 to 180 degrees, and then repeats this progression and declination from 180 degrees to 360 degrees.

WHY CURRENT ALTERNATES.

The principle on which electric current alternates is this: An increase in the number of lines of force embraced by a circuit induces a current in a certain direction, depending upon the direction in which the conductor cuts the lines of force. (In the accompanying diagram 5, it would be away from the observer, on the left side of the loop and toward him on the right side.) And a decrease in the number of lines of force embraced within the circuit induces a current in the same direction in which the hands of a clock move. Applying this to the diagram, we may say that when the loop moves down 90 degrees from a vertical position, on the side marked N, and up on the side marked S, the number of lines of force embraced within the rectangular loop gradually decreases, and consequently the current induced will be in the direction in which the hands of a clock move. In this case, it will be away from the observer on the side toward S and toward him on the side N. Now, as the loop changes its position with respect to the number of lines of force it cuts at right angles, the direction of the current induced changes.

It will be observed that each end of the loop is attached to a ring, known as a *collector ring.* These rings revolve with the loop and draw off the current in alternating directions, positive thru one-half revolution of the loop, and negative thru the second half of the revolution.

The next step in building up the action of the generator on the screen, is to remove the drawings of the loop and brushes from the background and to lay other celluloid plates upon it. One of these (figure 5) is a view of an "H" armature; the second (figure 6) is a view of the loop, and the third (figure 7) is the "H" armature containing many loops wound in the form of a coil. The action previously outlined takes place in greatly increased measure within the armature shown in diagram 7. By removing the single black loop and substituting a cross-sectional view of the interior of the armature, an idea may be obtained of the mass of wire within it. As the strength of a current depends upon the number of wires cutting the lines of force, it is evident that the desirable condition is obtained when a great number of wires are wound closely together in the armature. Figure 8, the lower and final stage here shown, shows the current being taken off by means of brushes and slip rings.

Electricity from Water Power

By H. WINFIELD SECOR

(*Continued from page* 395)

ing with a wooden mallet over a mandrel of the proper shape, and the securing tabs or bent over ribs also formed. These securing tabs may be drilled for rivet holes before being bent over if desired.

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(Extracts from Kent's Handbook)

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6	30	12.70	2635.62	837	.10
6	40	17.32	3043.39	969	.15
6	50	21.65	3402.61	1038	.21
6	60	25.98	3727.37	1185	.28
6	70	30.31	4026.	1281	.35
6	80	34.64	4303.99	1368	.43
6	90	38.97	4565.04	1452	.51
6	100	43.30	4812.	1530	.60
6	120	51.96	5271.30	1677	.79
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THE "MASTER KEY"

By CHARLES S. WOLFE.

(*Continued from page* 374)

marvelous happenings of fiction. The dispute grew rather hotter than either of us liked, and—well, we ended in a bet.

"Fair offered to bet me five thousand dollars that he personally could demonstrate to a selected committee that the mysterious entrance or exit from a room as described in this book was quite possible. I accepted the wager.

"The committee was selected, and the conditions agreed on. He was to enter a room from which no unaided exit could apparently be made. He was to be allowed the entire night in which to effect his escape. If he succeeded, I agreed to find him within 48 hours, and to explain how he got away or forfeit the wager.

"The arrangements were made, and he entered the selected room at eight last evening. This morning we forced an entrance to that room. He has disappeared!"

Fenner made no effort to conceal his grin. "Put one over, eh? Any idea how he managed it?"

"Not the slightest," confest Watson, dejectedly. "Apparently it is impossible. Yet he is gone. My forty-eight hours are slipping away rapidly, and it seems as if I am slated to lose. I don't mind the money at all, you understand. I would give the little devil that much if he asked for it. It is the idea of having the young jackanapod hoodwink me in this fashion that makes me determined to find him if I can. Yet I haven't an idea where to begin. Now I am making you this offer. Solve this riddle for me, and the money I win you may have. Of course, I rely on you to keep secret the fact that you aided me."

"That's a pretty stiff condition," objected Fenner, "for how I am to get a look at the scene of this mysterious disappearance without someone noting my presence there, and how I am to trace the movements of Fair without following any trail he may have left without seeing it is more than I can imagine."

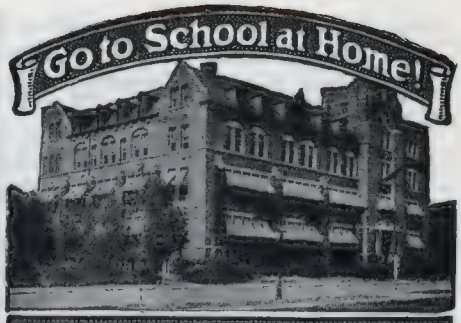
"That you can easily do," returned Watson. "The selected room was in the Commercial House. This morning we forced the door, doing some little damage. I told the proprietor that I would send workmen around to make the necessary repairs. You may represent yourselves as locksmiths without arousing any suspicion."

"Right," Fenner agreed, cheerfully, "and now, Mr. Watson, give me a concise account of Fair's last movements."

"We finally chose a room on the twelfth floor. Fair accepted this room without comment, and it suited me. It opens onto a long corridor, which leads to the elevator. It is much like the other rooms on that floor. The reason that it appealed to me was that it was situated quite a distance from the fire escape. In fact, it is inconceivable that Fair past out thru the windows of the room."

"Granting that he had the nerve to venture out over the abyss, couldn't he reach the roof?" queried Fenner, quietly.

"Watson shook his head in negation. "Three stories above, and the out jutting cornice, you know. Practically no hand or footholds on the surface of the wall. I don't imagine a cat could make it. I think we can eliminate the windows. The hotel proprietor assures me that there are no secret passages, spaces between the walls or anything of that sort in the building. I take his word for it. Now as to the doors. There are two. The one leading into the room from the corridor by which Fair entered, and one within the room in the left wall, leading into an adjoining room, which also has a door opening into the corridor.



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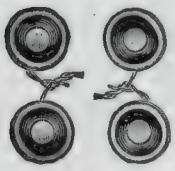

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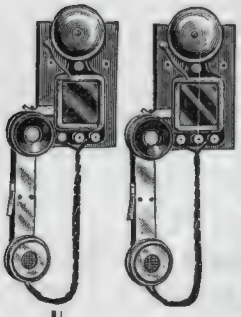

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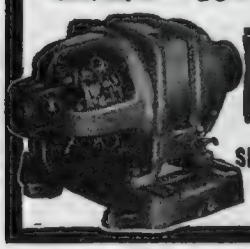

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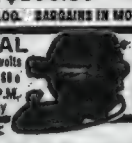

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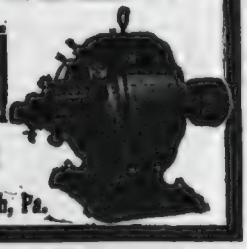

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"Both these doors have ordinary locks, not dead latches. For this reason, I suppose, they have also bolts. There is a bolt on the inside of the door which opens on the corridor, and a bolt on the door within the room. There is a bolt on the other side of that door, by the way, within the adjoining room. I looked this morning. And for the occasion we put a bolt on the outside of the corridor door.

"When Fair entered the room we shot this outside bolt. He shot the one on the inside. That's why we had to force our way in this morning. That bolt on the inside was still in place. So also were both bolts on the other door. And there you are."

Fenner arose. "Your description of the conditions is good, Mr. Watson," he said, "and now Bill and I will become locksmiths and go down and see if we can do anything for you. If I am able to help you out, I'll call Davidson on the 'phone."

"Do that," agreed Watson, "and remember, the money is all yours if you can successfully unravel this mystery."

Fenner nodded, and we past out, leaving Watson seated at the table. As we past thru the outer office, Davidson favored us with a wink and a grimace to which Fenner replied by forming with his hands a very creditable imitation of the long ears of a mule.

We made our way to Fenner's house, attired ourselves in working clothes, took a few tools, and caught a downtown car. As we rode I ventured to question Fenner, hoping that he might have a possible solution to the riddle. He proved non-committal.

"Wait, Bill," he said, "until we have had a first-hand look at the scene of this fourth-dimensional chap's activities. Let us form no theories until we know all that is to be known about the case."

"Watson's description was quite lucid," I replied, "and if things are just as he described them, the trick seems impossible to me. Fair couldn't have flown, you know."

"No matter how impossible it may seem," rejoined Fenner, "you are face to face with the fact that when they broke into the room this morning Fair was gone. That, I take it, is proof enough that it is quite possible. Here we are."

On stating our errand to the manager, we had no trouble in securing admission to the room, and the departing bell hop left us alone in the room from which Fair had contrived to find an exit.

The damage to the door was trivial and Fenner set about making the few necessary repairs. "You search carefully, Bill," he said, as he applied himself to the task of replacing the torn off bolt and its keeper, "and make sure that our young friend is not here, disguised as a bed or a clothes tree."

Ignoring the banter I did make a thoro examination of the room, having come to the conclusion on the way down that Fair might just possibly have remained in the room, avoiding detection by some clever expedient.

My efforts were fruitless, however, for a search convinced me that he could not possibly be in hiding within the room.

Conditions were just as described by Watson, there being no disorder or sign of unusual physical effort to suggest a possible answer to the enigma. A glance out of the window assured me that Watson had spoken the truth. Just to fancy a human being clinging to the surface of that wall at that height was sickening, and I felt convinced that Fair had not made the fire escape. Yet the bolted doors seemed proof that he had not past thru either of them, for it is possible to lock a door after you, but hardly so to bolt one on the other side of a closed door. Also the fact that there were bolts on the outside of each of these

doors made it look like a rather difficult proposition for him to have opened them at all, let alone bolting them behind him.

The ceiling, examined from the vantage point of a chair, was as fruitless of clues as the previously scrutinized floor.

"And now," said Fenner, after these details had been attended to, "we will take a leaf from Watson's book, and have a look at the adjoining room."

By means of an ordinary skeleton key we readily got into this chamber thru the corridor door. I prepared myself for another thoro search, but Fenner stayed me, "No use, Bill," he said; "let's go."

Mystified, and a little rebellious, I followed him from the room, and we made our way to the street.

As we walked along, Fenner hummed softly under his breath.

"It wouldn't have done any harm to have taken a look around that room," I grumbled, "on the off chance. While he's not likely there, we might have made sure."

"Nor would it have done us any good. Ah! there's a telephone booth. Wait here until I get Davidson and kiss that five thousand good-bye."

"Are you giving it up?" I demanded, amazed and hurt. "Let's go back and have another try."

"Not on your life," said Fenner, grimly. "Lead us not into temptation. If I go back there I may be tempted to collect that money."

"You'll never collect it this way," I demurred.

"My boy, I don't want to collect it," retorted Fenner. "I don't need money that bad. Watson's a short sport, or he would have seen this thing thru himself, and not asked to buy the brains which he apparently lacks. Fair on the other hand has proved himself the possessor of some real gray matter. Get me? I'm going to be something of a good sport myself and not give him away."

I laughed, shortly. "Give him away," I echoed. "I hardly think you will!"

Fenner stopt short in his tracks, nettled. "Say, you ass," he said, sharply, "you don't think I'm stumpt, do you? Let me tell you something, fellow. I know where that lad is at this very moment."

"You do?" I yelled. "Then where in blazes is he?"

"In that room that I wouldn't let you search, my boy," rejoined Fenner, complacently, gratified by my startled expression. "That's why I literally dragged you out. I didn't want you to flush the poor lad and spoil it for him. He was in that big closet, sticking out his forty-eight hours."

"He was?" I demanded, in amazement. "How did he get thru that bolted door?"

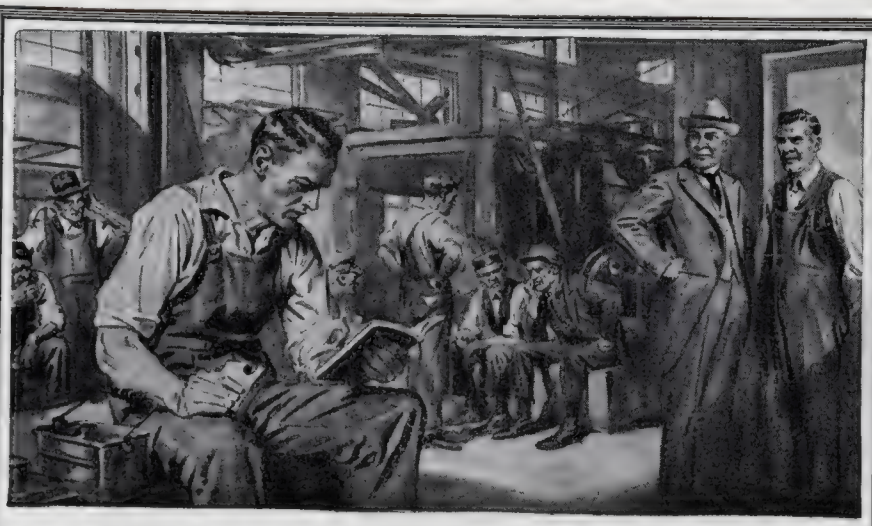
"Easiest thing in the world," chuckled Fenner. "A cinch. He had the MASTER KEY."

"A master key for a bolt?" I demanded, incredulously.

"A master key for a bolt," Fenner said quietly. *"A nice little electro-magnet and some lamp cord.* Simple, wasn't it. Hook right into the lamp socket and shoot the bolts about at will. He figured, and rightly enough, that the fact that all those bolts were found safely in their keepers would ward off all suspicion that he merely stept into the adjoining room. He was right when he told Watson that things happen in every day life that are stranger than fiction. Maybe that worthy will believe him now."

"Good night!" I murmured, dazedly. "I never thought of that method—never suspected the trick."

"I did," replied Fenner, "and just the moment that I saw those bolts were of steel and not brass ones, I knew that I was right. Gee! Couldn't we have rigged up some station with those five thousand iron men!"



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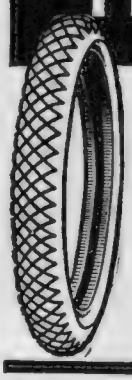

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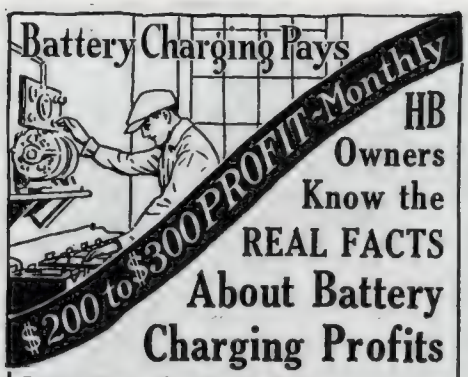

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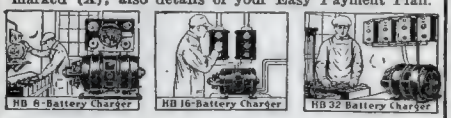

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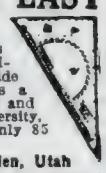

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Electric Sand-Hog to Salvage Ships

By ERIC A. DIME

(*Continued from page 357*)

tion of the machine contains an electric motor and the mechanism used for guiding the device while in operation. All the machinery is enclosed in a watertight metal casing. The burrowing apparatus is connected by means of a cable to the wrecking tug above. The cable contains the feed wire for the motor and other wires employed for controlling the speed and direction of the device, as it is digging its way.

LOCATING THE WRECKED SHIP.

Operations begin with the location of the wreck. Various methods may be employed for this purpose. If the ship rests at a depth of a hundred feet or less, it can be located by means of an airplane. Cases are on record where aviators have located wrecks because these appear like a dark shadow to the men flying at heights of from 500 to 1,000 feet. Should it happen that the vessels lie at depths of more than a hundred feet, they may be located by means of a drag-line attached between two tug boats. The boats may be separated to a distance of from 1,000 feet to a quarter of a mile, and the wide sweep of the line would be caught in the wreck and the latter thus located. Still another method of finding the resting place of an ill-fated ship is by means of an electrical detector. This consists of a coil of wire attached to the end of a cable dragged along the bottom of the sea, as suggested by Dr. Alexander Graham Bell. When the coil approaches the metal of the ship or some other metal part, it will change the electrical inductance in a telephone circuit connected with it.*

When the ship has been found, the burrowing machine is lowered close to the wreck and a diver is despatched from the wrecking tug. If the vessel is in shallow water, the diver may be equipt with an ordinary diving suit. On the other hand, if the wreck is at such a depth that the water pressure is too great for a diving suit made of fabric, a metal diving suit is employed. There is so little work for the diver to do that the necessary movements with the arms can be done, even if heavy water pressure should interfere with the action of the joints in the arms and legs of suit. Mr. Saliger has designed a metal diving suit which, he claims, has more freedom of action than those in use today.

The diver places the burrowing machine in the right position for the first hole or passage and then signal by means of a telephone to the men on the tug to start the motor in the machine. When the latter has dug in, the diver is raised to the surface to wait until the *mechanical mole* has finished its course under the hull of the ship. Then the diver is lowered again and he attaches a cable from a derrick on the wrecking tug to the nose of the burrowing machine which is hoisted to the surface.

An ingenious feature of this sub-sea mole is the mechanism by which its course can be controlled by the operator on the tug above. The position or angle, which the device holds as it burrows away, is automatically registered by means of small electric lights with colored bulbs on a control board in front of the operator. For example, when the nose of the machine is pointing downward at, say, an angle of 45°, this position is registered by one set of colored lights, white, for instance. Should the machine move on an even keel, this would be indicated by blue lights, and when the nose points upward, as it must when emerging on the opposite side of the ship, red lights would be the signal for this.

*See article on detecting submerged ships in our October 1919 issue.

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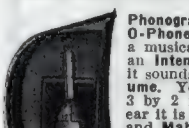

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When the device has completed its course, under the hull of the ship, the diver must locate the machine. Under ordinary circumstances this would not be an easy matter. It is obvious that in the darkness prevailing at the ship's depth and that the nose of the machine is barely above—or flush with—the surface of the ocean's bottom, it would be difficult for the diver to pick out the particular spot, where it is to be found. This difficulty has also been overcome in a clever manner by the inventor. He has installed a little hammer, operated electrically, in the mechanism of the machine, and by pushing a button on the control board above, the hammer gives a series of sharp knocks by striking metal. By the noise thus produced, the diver is able to locate the burrowing device.

A CATERPILLAR TRACTOR HELPS THE SALVAGING WORK.

In addition to the burrowing machine, Mr. Saliger has invented a caterpillar tractor combined with hydraulic sluicing. This tractor is designed to take the place of the burrowing device, where the sea bed is of such a nature that the latter would not work.

This tractor resembles very much an armored tank, altho of miniature size. Its dimensions are four feet wide, three feet high and five feet long over all. It has caterpillar belts on top as well as below, the two sets being essential for propulsion where a tunnel is dug. The front of the tractor has hydraulic nozzles thru which water is forced at great pressure.

When all lifting cables have been placed under the wreck, everything is ready for attaching the pontoons. These are resilient and collapsible. They are made of rubber and strong fabric and when inflated have the shape of a gigantic football. A network of ropes surrounds the pontoons, thus helping the fabric, when inflated, to withstand the air pressure and at the same time serving as the support for the lifting cables.

The rigid wood or steel pontoons, which are universally used at the present time, have certain drawbacks. In the first place, they require a heavy hoisting and hauling equipment. Furthermore, they are impractical save in sheltered waters, because the slightest storm may wreck both the ship and the surrounding pontoons by pounding and grinding them together.

FLEXIBLE NON-DAMAGEABLE PONTOONS RAISE SHIPS.

In order to overcome these difficulties, Mr. Saliger devised his collapsible pontoons which require only one tugboat and its ordinary equipment. The secret of success of these pontoons is found in their construction and in the mechanical devices used in connection with them. Each pontoon has a lifting capacity of 25 tons. They are attached to the lifting cables under water in a deflated condition and the number required, of course, depends on the size of the ship. The pontoons may entirely encircle the hull, or, if necessary, surround it in rows of two or three deep. When they are once in position, the wrecking outfit above pumps air into all the units simultaneously. When all are fully inflated, it is evident that the ship must rise, thus obeying one of the immutable laws of nature.

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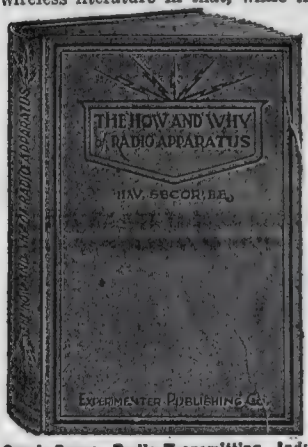

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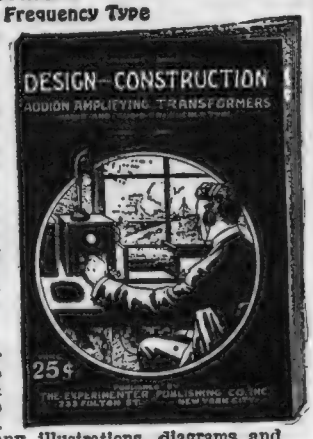

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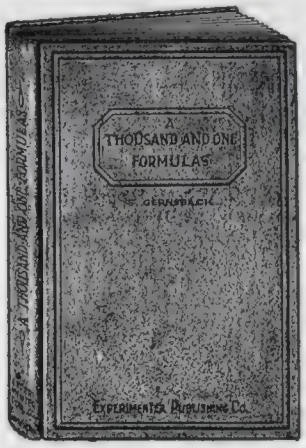

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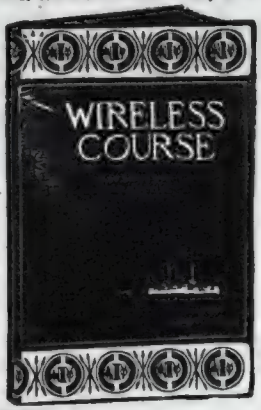

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SPECIAL NOTICE.

Of late we have received so many letters from our correspondents regarding patent advice, that it has been quite impossible to publish all of them.

Altho printed in the smallest type possible, we cannot accommodate more than ten or twelve answers a month. At the present time we are about four months behind. Of course, if our correspondents have time, no harm is done! We would, however, advise that if a quicker answer is wanted, correspondents should avail themselves of our special service, as per the notice printed at the head of this column.

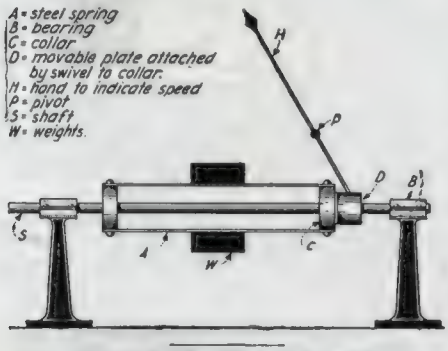
All letters are answered in turn as they come into this office, and for this reason it will be understood why it takes so long for an answer to be publisht. Will correspondents please bear this in mind?—EDITOR.

SPEEDOMETER

(396) Carroll Coleman, Muscatine, Iowa, writes: I would like to ask your advice on a speedometer of which I am enclosing a diagram.

The power would be transmitted to the end of the shaft in the ordinary way. The faster the shaft revolves the farther the weights would spread apart, causing the end with the movable plate to move closer the other end, also causing an increased movement at the other end of the hand.

A. This seems to be a good idea, and while similar schemes have been used in the past for other purposes, we have never seen it applied as a speedometer, and we think that it is possible that if the instrument would be self-contained, a patent could be obtained upon it.


A = steel spring
B = bearing
C = collar
D = movable plate attached by swivel to collar.
H = hand to indicate speed
P = pivot
S = shaft
W = weights.

INCANDESCENT LAMP.

(397) Mr. M. Maltz, Passaic, N. J., writes as follows: "I discovered a new method of lamp construction. The method does away with stem making, flare making, sealing in, and combines basing and exhausting of lamps in one operation. The base has copper lead wires soldered to sides and bottom, base is then filled with compound and filament attached. When proper degree of vacuum is obtained, bulb settles into compound, sealing itself therein."

A. The idea is highly ingenious and quite clever, but the only draw-back is that the heat of the lamp will sooner or later soften the sealing compound and get into the lamp.

Even if a compound not affected by heat were used, we doubt if a sufficiently good vacuum would result for ordinary purposes.

DRAFTING INSTRUMENTS.

(398) Mr. D. Guigue, Montreal, Can., has this to say:

Will you please give your opinion as to patentability, etc., of the following idea for improvement in drawing instruments?

Pieces 1/16" thick are glued on to triangles as indicated by sketch. Of course, instead of pieces being glued on, the angles could be formed in one piece. The advantages are: 1st—There would be no danger of the ink getting under the edge of the instrument and making blots when drawing lines. 2nd—There being a space between the pieces, the instruments could be used over wet lines.

A. The idea is a very good one, altho similar appliances are on the market today, and we doubt very much if a patent could be obtained upon the slight improvement. A design patent might be obtained, and we advise our correspondent to get in touch with a patent attorney.

RATCHET WRENCH.

(399) Johnson A. Holmes, Manchester, Kansas, submits a design of a new ratchet wrench which works on a novel principle. This wrench does away with the necessity of taking off the wrench each turn and putting it on again; hence, it saves time and also works better in a tight place.

A. A very clever idea, and we are sure a patent can be obtained upon it. There is a good demand for such a wrench on the market at the present time, and if it can be sold at a reasonable cost, we should think there would be a wide demand.

SEALED-IN DETECTOR.

(400) Albert Ruff, Superior, Wis., states: I have made several permanent crystal detectors by sealing the catwisker onto the mineral with a certain compound. I have made permanent detectors by this method that copy Arlington at a distance of 900 miles with a comparatively simple amateur outfit. The detectors remain permanent indefinitely with proper handling and require absolutely no adjustment. I am enclosing sketch on separate sheet. I would like your advice as to its patentability, etc.

A. There is nothing new contained in this invention, as many detectors of this kind have been described in this as well as other periodicals for a long time.

DOUBLE COAT.

(401) Newton Rhodes, Albany, N. Y., requests the following information:

I would like to know if a patent can be obtained on a "double coat"? My idea is to take a light weight overcoat and put a heavy fur lining in it, attaching it by several buttons. The coat being light weight can be worn with comfort during fall and spring and in winter can be made warmer or heavier by attaching the lining, thus making the one coat do for two. I have tried this scheme and find that it works.

A. At the present time reversible coats are on the market, but these, of course, work on a different principle, i.e., the coat can be pulled inside out without the use of the buttons mentioned by our correspondent. We should think, however, that the idea is patentable, but as a precautionary measure would advise our correspondent to have a search made in the patent office.

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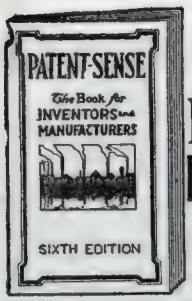

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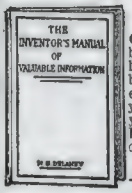

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SHOE DEVICE.

(402) Herbert Skinner, Oxford, Ohio, wishes our advice on the patentability of the following:

"When the ice is on the sidewalks and streets, people find it very hard to stand up. My idea is to have a cleat put on one's heels the same way that heel plates are put on. There will be points in this plate which will stick in the ice. On the other side will be some projections which will stick in the heel and hold it on. The advantage of these over the ones which strap on is that they are invisible and they do not have to be taken off every time one goes in the house. This outfit would be much cheaper, too."

A. This is not a new idea at all, and there are many devices on the market at the present time that accomplish the same thing. We have in mind particularly, a simple article which attaches to the shoe, which can be unfolded, having on one side spikes to prevent one from slipping on the sleet or ice-covered streets. Normally the device folds back and rests between the space of the heel and the sole.

PATENTS.

(403) J. B. McClellan, Monongahela City, writes: Through your *Patent Advice* I would like to know the following:

If an inventor makes public a certain invention or has it witnessed and signed by a notary public, would a patent be allowed on the invention if the inventor has his patent attorney, whom he employs, get out his patent, act as witness, sign specifications, etc.? Could this be considered lawfully executed by the patent office?

A. As far as we know, one of the finest claims of priority is established by having the article known to as many of your friends as possible. After specifications have been written up and signed by a notary public, if desired, a duplicate copy can be placed on a large *post card* and can be mailed to yourself or a friend.

If it is then published in a magazine, it establishes a third claim of priority. The patent office also, however, rules that some attempt must be made at obtaining a patent within one year after its first publication. A very good method of establishing priority is to daily record your activities in a notebook and not forgetting to put the date on the page. At the end of the year you can have the notebook stamped by a notary public or once a month, if desired.

A patent, however, is the best, but if your funds are insufficient, publication in some magazine will constitute the next strongest claim, lasting only one year, of course. If, during that time, some manufacturer sees the practicability of your device, he will be very glad to help you in your patent.

NEW TRACTION SCHEME.

(404) O. W. Hammarlund, Rumford, R. I., writes: I am at present experimenting on an electric-gasoline system of transportation. I have spent quite a lot of money on it, and before I do much more I will have to interest capital.

I have been using a 6-cylinder engine which is rated at 31 hp., but develops 48 at 4,000 r.p.m., and been driving it at a 25-k.w. speed for an electric generator direct connected to it. This plant is set on a chassis and is to be propelled by a 5-hp. series motor, and four other chasses for either passengers or freight. Each will be propelled by 5-hp. motors and coupled mechanically and electrically together and controlled from one point.

As a 3 1/10-hp. motor is used on two-ton electric trucks to propel combined weight of vehicle and load of 12,000 pounds at a speed of 8 to 12 miles per hour, a 5-hp. motor should propel my cars at faster speed. The engine will run all the time except on long stops and the units can be made up of 2, 3 or 4 cars, just as the traffic demands. I think I will have very little trouble with the control of the system.

The power plant at the load is a logical answer to the street car question, as a 34-000-pound vehicle to transport less than 6,000 pounds is a very inefficient idea where miles and miles of copper and steel, with their losses and cost of maintenance, are also needed, without which they are dead.

The old 50-ton locomotive will pull more, and the need of its weight is because this is required for traction, where if an electric motor was put on each coach or car far better results would be obtained and using a turbo generator to drive them.

A. Your idea is surely feasible and very practical as far as its mechanical possibility is concerned. As yet no one has thought of using a gasoline engine in connection with a series of cars such as you explain and no difficulty should be experienced at all with the control system.

Furthermore, you would experience very little difficulty with operating on railroad track, as only 16 pounds of energy is required to move one ton of stock on wheels, provided the same is on a railroad track, and we believe its speed, as high as 25 to 30 miles, could be obtained with little difficulty. It is quite possible, however, that if your gasoline engine were coupled directly by coercion to the wheels of the car, you would get a greater horsepower.

On the other hand, it would seem that a more even distribution of the power along a train of cars tends to cause safer and smoother operation. Whether the device is going to be a commercial asset and can be adopted to a very great extent is hard to say, as no patent could really be secured on the same, inasmuch as gasoline engines, motors and generators have often been coupled together, unless you can secure some intrinsic patents on the controlling method.

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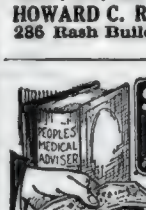

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The Electrical Machinist

By H. WINFIELD SECOR

(*Continued from page* 400)

MISCELLANEOUS ASPECTS ON MAGNET FRAME CONSTRUCTION.

Before going further, an interesting experiment which was performed accidently one time, and which came under the writer's observation, will be mentioned, as it happens to show vividly, the important effect of shunting even a part of the magnetic flux from the field-poles of a dynamo or motor. At Fig. 3-A, the experiment in question, is illustrated. One of the men in the shop happened to have in his hand a large wrench, and was testing a motor which had just been rewound, rated at about ½ horse-power. The motor was of the vertical bi-polar type as illustrated, and unthinkingly, or else in a spirit of experimentation, he approached the wrench toward the top of the two salient field-poles. Before he could catch his breath, the powerful magnetic flux acted on the wrench and slammed it out of his hands and down on the poles. The next minute the armature of the motor, due to the shunting of a great part of the field flux thru the wrench, and the consequent weakening of the active field, started to fairly whistle as its speed mounted skyward. This is an important thing to know, for several reasons. One of them is that you can regulate the speed of a motor or the voltage of a dynamo, by a simple iron shunt arrangement, which may be strongly built so as to be controlled by a wheel or gear, acting in the manner just described. As you approach the iron shunt bar towards the field-poles, the field acting on the armature is weakened, and the motor speed raised or the voltage of a dynamo lowered.

As the iron shunt member recedes from the field-poles, the motor speed approaches normal or the voltage of the dynamo will increase toward normal.

In the Stow variable speed motor, the field pole-shoes are caused to recede from or approach the armature by means of a special gearing arrangement, which simultaneously moves all the pole-shoes whenever a gear wheel on the exterior of the machine is turned. This, as will be seen on reflection effects the same results; that is, it weakens the field or raises the armature speed, whenever the pole-shoes are moved away from the armature owing to the larger air gap and consequent higher reluctance offered to the magnetic flux. As the pole-shoes are approached to the armature, the air gaps are reduced in length, the magnetic reluctance is also lowered, and the armature reduces to its normal speed.

As the field flux lowers on the motor armature in any case, the rotating member will tend to increase its speed in an effort to generate its usual quota of counter electro-motive-force. As this counter emf., is dependent upon the number of armature conductors, the speed of rotation and the magnetic field flux in maxwells per square inch, it is evident that if we reduce any one of these quantities then one or more of the others must be increased. Therefore, as the field flux is reduced, the speed will tend to increase as the number of armature conductors is already fixt, and in order to generate the proper counter emf., the armature will rotate faster and faster as the field flux is weakened to try and produce sufficient emf. to buck the line voltage applied to the motor, in order to keep the armature current down to the proper value. It is this important fact which accounts for the rush of current when a D.C. motor is started, and the reduction of the current consumption as the motor speeds up; in other words

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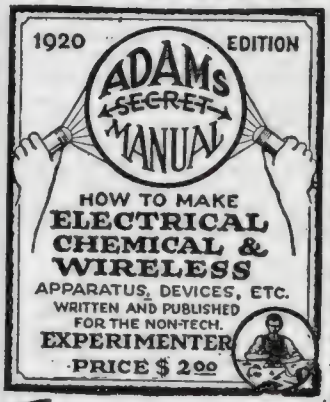

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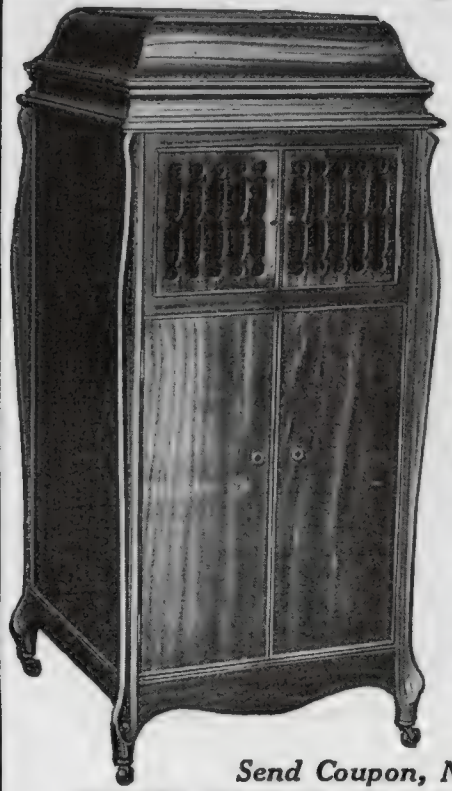

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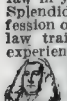

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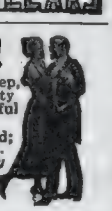

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the counter emf., builds up as the speed of the armature increases, and a greater emf., bucks the applied line voltage.

On a 500 volt motor, the counter emf., would be about 500—22 volts, the resistance drop in the armature, or 478 volts. The armature must therefore run at such a speed under a given strength of field, as to develop therefore 478 volts when the machine is operated at normal voltage. It is thus evident why starting resistances must be cut into the armature circuit when starting motors, particularly those of the shunt and compound type, until the armature has reached its normal speed and started to develop its regular and full value of counter emf.

At Figs. 3-B and C are shown two recommended methods of assembling and clamping laminated or sheet iron magnet frames, such as those found on motor stators and rotors. Brass bolts are best used in assembling stator frames, altho steel bolts are used considerably, and are best placed in fiber sleeves with fiber washers under the clamping nuts, to prevent the production of eddy currents. On medium and large size armatures having a steel disc assembly on a shaft, it is considered the best practise to mount these on a gun metal, fiber or brass sleeve of a thickness dependent upon the size of the armature, and not to drive the steel shaft directly thru the laminations; as when this is the case, there is liable to be more or less unnecessary eddy current and hysteresis loss.

(*To be continued.*)

What To Invent

By JAY G. HOBSON

(*Continued from page* 411)

LIQUID BEARD REMOVER.

Many have been the attempts to compound preparations to successfully remove the beard from the face without injuring the skin. None that I know of, has succeeded, and right here please let me record the importance of such a discovery.

How wonderful the banishment of razor slavery will be when the *liquid shave* is perfected. Just imagine the joy of shaving with the ease of washing the face. Some day this great preparation will be invented which will see millions of men gladly switch from the old hoe-method of today.

A special preparation that would quickly dissolve the hair and *not* the skin, seems to me as being the practical goal to work for. One that will be both cleansing and antiseptic will make many masculine converts shout with joy.

GRAPE FRUIT GUARD.

A few mornings ago I was piloted across the hotel dining room by the head waiter, and sat me down to a table where the garcon was already serving three *grape fruit enthusiasts.* Unfortunately I joined them as all three started to operate on their "nature squirt guns," and as I sat there patiently waiting for my half, the bombardment began! All three companions had their juice artillery pointing away from their eyes and *directly toward mine.* They were very harmonious with the eating tools it seemed, for each plunged after the "aquacitrus," with the same vim which sent a triple stream over my way inundating me almost entirely. Had it not been for my "specks"—my eyes surely would have been blinded.

After the deluge (necessity being the mother of invention), I imagined what I believe to be a practical device for every dining room; a *grape fruit guard* like the one shown in the illustration—a device made of glass and metal. The bottom or

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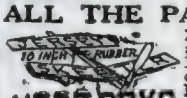

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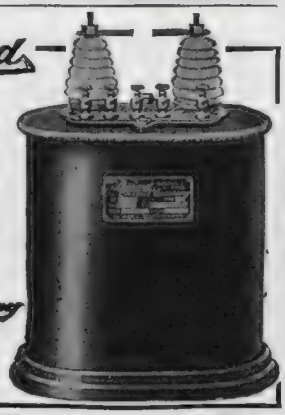

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holder part is deprest in the center to hold the grape fruit securely. The glass is crescent shape and supported above by three metal rods. The grape fruit is placed in the metal holder and under the glass.

The glass is high enough to allow a spoon to be manipulated underneath. In operation the user holds the fruit with one hand, places the spoon in the fruit under the glass, which acts as guard in preventing the juice from getting into the eyes.

The grape fruit habit is a popular one. Every eating place serves them. A practical and attractive device for this purpose certainly would sell big and make lots of money for the inventor if properly handled.

100 H. P. Voice for Conventions

(*Continued from page* 360)

mic counting came weirdly out of the mist. But the test which counted most was the vocalizing for a vast outdoor audience in the New Jersey Velodrome, the judges' announcements of the bicycle races.

There have been various demonstrations of earlier apparatus, but beyond the tests necessary to assure complete success, the demonstration at Chicago was unprecedented in the history of the world. The first speaker addresses the delegates. The sensitive transmitter is ready at the front of the platform above the heads of the correspondents. The speaker does not have to speak into the specially sensitized transmitter, but may walk back and forth at will. The sound of his voice is carried to the amplifying apparatus. This sound has been imprest upon silent electrical waves, which are gradually stepped-up by being given greater electrical force. The force of the original wave carrying current is magnified many thousands of times before it is delivered to the loud speaking receiver and there converted into sound. The loud speaking receiver or horn and the speaker himself are perfectly synchronized and the human speech mingles with its electrical counterpart in complete unison. The nearby audience hear the speaker and the loudspeaker as if it were one voice, while the more distant audience hear only the loudspeaker.

Back out of sight is the Control Room where is located the *Deus ex machina*—the wonderful amplifying apparatus. The speaker's voice waves strike the diaphragm of the sensitive transmitter and the electrical energy generated by this transmitter is conveyed to the loud speaking control board in the Control Room, from thence passing thru the amplifiers after which it is delivered to the loud speaking receiver and there converted into sound. Before it reaches the loud speaking receivers it may be amplified many thousand times.

The transmitters, of which there are two, comprise microphone buttons mounted in highly resilient supports within the protective boxes observed in front of the speaker. The loud talking reproducers are built somewhat on the order of the Magnavox, i.e., they involve an electro-magnet of special construction acting on a crimped diaphragm of large size. The three horns are of wood, suitably braced with wooden ribs along their sides. The horns are connected on parallel.

CORRECTION NOTICE.

In the April issue there appeared an article entitled, "New York Has Ozonized Water." Thru an unfortunate oversight on the part of the editors the name of the inventor of this system of ozonizing water, Mr. A. J. Moisant, of New York City, was omitted. We are glad to call our readers' attention to this omission.

When this test comes it won't be a question of how brave or strong you are, but of whether you know how to defend yourself.

Brave but helpless

Deep down in your heart you know if you were called upon tonight to defend a loved one, you couldn't play the part. That if a bully spoke insultingly to your mother or sister you couldn't teach him a lesson. That if you were attacked on a lonely street you couldn't overcome your opponent.

You're not a coward—but you don't *know how.* When the test comes, it isn't going to be just a question of bravery, but whether you know how to box, how to disarm your opponent, how to stop the kick he launches at your stomach, etc.

Don't you see that in justice to those who look to you for protection, it is your duty not only to be *willing,* but *able* to play a man's part. Your excuse that it takes too long, or that you haven't the money to learn, no longer holds good, for boxing and self-defense are being taught successfully by mail to over 10,000 pupils—*at less than half the cost of the usual term of lessons by the old method.*

Just as scientific teaching reduced the time of learning to swim to a few lessons, so the Marshall Stillman "Shortcut" method has reduced the teaching of boxing to 5 lessons. The instruction takes place before your mirror, so that you learn the rudiments (the hit, guard, duck, feint, clinch, and footwork) before facing an opponent. Then you know how to hit, what to expect, and how to guard against it.

In a few more lessons you learn how to disarm an opponent and how to get out of dangerous holds, etc. To show how simple the lessons are, we quote instructions on how to break a strangle-hold on your throat: "If your opponent has both hands on your throat and is choking you, don't try to choke him, don't pull at his wrists and don't try to hit him. Simply reach up with your two hands and take hold of his two little fingers and give them a quick bend back; break them if necessary; he will let go."

Simple, isn't it? So are all the lessons in the course. The complete course includes:

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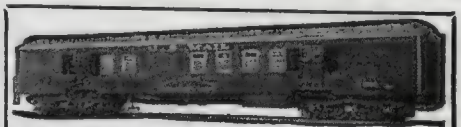

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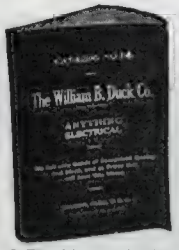

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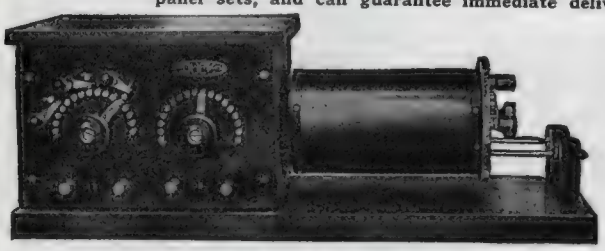

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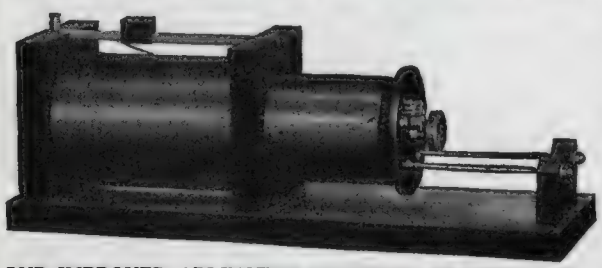

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The "Ultimate Ray"

By RAY WHITCOMB

(*Continued from page* 372)

panting and numb for perhaps fifteen minutes while the storm raged furiously without.

Finally, as my strength slowly returned to me, I got up, shivering and miserable, and determined to find out where I was and, if possible, to obtain some dry clothes. Not thinking of where I was, I fumbled around on the wall for a switch, found it, and flooded the room with light. Even as I past the switch, however, and stood blinking in the light, I thought how unusual it was to have electricity in an out of the way spot like this.

The room in which I found myself was plainly but modernly furnisht as a library. A mission table stood in the center, chairs to match were set about and series of shelves nearly filled with books, completely occupied one wall. I took a step toward the books when a sharp click behind me caused me to whirl around.

Facing me, stood a short, stout, red faced man wearing a huge rubber apron and holding a businesslike looking automatic pistol trained squarely at me.

I stretched forth my hand and started forward—

"Stay where you are," came in quick, incisive tones, and he eyed me from head to foot with evident dissatisfaction.

So taken aback was I by this reception, that words failed me and I simply glared at him. He had evidently just cocked the revolver as a pudgy thumb still remained on the hammer. Broad, square-toed shoes peeked out from under the ridiculously large apron; his shirt sleeves were rolled up, disclosing an elaborate, tatooed design on his left arm; and a pair of immense goggles protruded from a pocket in the apron. A stubby beard of sandy color gave a ferocious aspect to him, and a thick mat of frizzley, brown hair surmounting a beefy, bloated face, was the remaining feature of this most singular person.

"Well," he snapt, at length, "I guess I've got you."

"And may I ask," I rapt back at him, "What you intend to do with me now that you have me?" My head throbbed painfully yet, and I felt decidedly out of humor at being thus treated.

"Hmpf!" he grunted, his little eyes narrowing down to slits. "Your visit is most inopportune. However," he laughed heavily, raucously, "I scarcely think the interruption need prove serious."

"See here, whoever you are," I retorted impatiently, "If this is the kind of hospitality that you offer a person who seeks refuge in your house from a violent storm, then I much prefer to remain in the storm." I took a step toward the door and stopt short as a loud report rang out and a clean hole appeared in the panel above my head.

"You will remain precisely where you are," he growled, "And if you make another move like that last one, I will reward you with a bullet between the ribs."

Not wishing to risk enraging him, for I was now about convinced that I had to do with a mad man, I shoved my hands into my wet trousers' pockets and leaned up against the door.

"Very sensible," he commented, then continued, "You came here to kill me and steal the result of my lifetime's work. Your very pretty explanation failed to impress me, and I have you just where I want you. Take that hatchet out of your belt and lay it on the floor—and be mighty careful how you do it!"

I did as he commanded, altho feeling strongly inclined to hurl the thing at his evil, sneering countenance.

"You are making a lot of trouble for yourself by this outrage," I flung at him angrily, "and I shall——"

"That will be enough from you," he cut in sharply. "You will do as I say and you will make no remarks about it either. Turn around and face the door with your hands behind you."

As I turned around, I heard him open a drawer and come up behind me. In a few moments my hands were securely tied behind my back, and making me lie down, he fastened my ankles in the same way. Then, without a word, he seized my feet and began dragging me across the floor after him. Thru a door and along a narrow hall, we went, finally going thru a second door into a brilliantly lighted room. I heard him slam the door and bolt it; then I was roughly jerked up into a sitting posture on a bench (the man must have been a physical giant from the way he handled me).

His attire together with his remark about "a lifetime's work" had rather prepared me for the sight which I saw. I was on a bench in one corner of a room fitted up as some kind of a workshop. On my right, four huge wooden vats and one of metal lined the wall, all having wires running to them from two well insulated mains that completely circled the room, starting from a large panel switchboard upon which were several meters, rheostat controls and circuit breakers. Next to the switchboard was a sink and a large electric furnace of the arc type, and between the switchboard and the bench upon which I sat, was a set of large shelves on which were numerous sacks and bottles. At the further end of the room was a work bench and beneath it were several acid carboys.

The room was lighted by a small arc lamp hung in the center of the ceiling and directly beneath it was a long wooden table resting upon heavy porcelain insulators. My captor was busily engaged in adjusting a rather curious piece of apparatus which was clampt to this table.

At first I could not make it out; but finally I decided that part of it, at least, was a large searchlight. In other parts of it, I thought I recognized a rheostat, a transformer, and condenser, while some pieces offered no indication as to their nature.

Tired of watching his endless puttering and tightening of screws, I closed my eyes. My head still throbbed and the report of the pistol had left my ears ringing loudly. All at once I became conscious of the crash of thunder. The numbing effect of the revolver shot at close range had helped to make me oblivious of the storm raging. There were no windows to the room and thus I had not noticed the lightning flashes.

Now, however, as the crashing of the thunder reached my ears, harsh and fearsome, I began wondering what Victor was doing; what he had thought when I failed to return; how he was weathering the storm. For the first time, I felt a twinge of fear as I realized that I was in the absolute power of this man who evidently had some wild notion that I had come to kill him and rob him of some secret, probably having something to do with this curious machine which he was working at. I had already, in fact, begun to work at the cords at my back, when his voice broke the thread of my thoughts.

"I have no cause for bearing you good will," he was saying, as I opened my eyes, "but I have decided to give you a demonstration before I dispose of you, of the power of my invention—the invention which you sought to steal on the eve of its completion."

He was standing facing me, with one hand resting on the table and the other thrust into a pocket of the apron. As he finished he adjusted the goggles to his head

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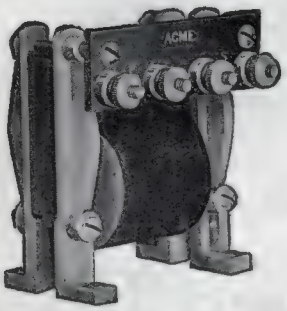

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and slipt on a pair of rubber gauntlets. Then, crossing over to the switchboard, he threw a huge switch and turned to me.

"No doubt you wonder how I detected your presence, as you probably figured that the storm would drown out all noise. As a matter of fact it would, and you might have succeeded in killing me, but for the fact that I happened to be standing in front of this switchboard at the time you turned on the light in the library. That was careless of you. I saw the meter fluctuate when the switch was thrown and guest the cause."

"That's a d——d lie when you say that I came here to kill you and you know it. And if you don't let me loose——"

"I should greatly deplore the necessity of gagging you, but unless you remain quiet, I shall be compelled to do so," came in his suave, harsh tones.

No reply to this was possible, so I remained quiet and glowered sullenly at him, meanwhile working continuously with the rope that bound my hands. It seemed to be giving slightly.

"And now," he went on, after a short pause, "I shall first describe the different parts of the apparatus which you see upon the table and with which you are probably familiar in a more or less degree. If I neglect to explain some point of interest, you are at liberty to question me."

The grotesque figure before me, the strange room, and the awful booming of the thunder, all combined to give me a feeling that this was unnatural, unreal,—a dream! I strove to convince myself that I was the victim of a hallucination, but to no avail.

The monstrous creature closed a switch on the table and a dim light sprang up within the cylinder which I had taken for a searchlight. Manipulating a large milled head at the back of it, he began.

"Observe the pilot light in the heat-generator. This apparatus is essentially a small searchlight in which the arc has been replaced by a filament of special alloy. Because this filament is never raised to a temperature high enough to cause it to emit visible radiations, some method of bringing to a focus the heat waves generated by the passage of the electric current is necessary; hence the pilot light which is merely a five-watt electric lamp arranged so that it can be placed in the center of the heating filament or swung out of the way by a simple lever system. We will focus the generator on the transformer by means of this screen."

Here he paused to move the so-called heat-generator forward by means of a rack and pinion movement until the image of a small lamp filament was thrown sharply on a small white screen about an inch square.

"Now by removing this screen, and the pilot light, and throwing this switch, current is past thru the heating filament and the rays or rather waves pass thru this small opening in the next apparatus and are refracted into a parallel beam about the size of a quarter by means of a plano convex lens of quartz glass especially treated so that very little heat is absorbed. I may mention that the lens in the front of the heat-generator is of the same composition and before I go any farther I shall digress for a few moments to say a few words about the theory upon which this next piece of apparatus is built. I call it my *ether vibration transformer.*"

He cleared his throat and continued, "You are aware, no doubt, that light, whether red or violet, is simply energy waves or vibrations of the so-called luminiferous ether, a postulated all-pervading medium. In the broad sense, therefore, of speaking of light as ether vibrations, it includes vibrations of all frequencies, and

(*Continued on page* 449)

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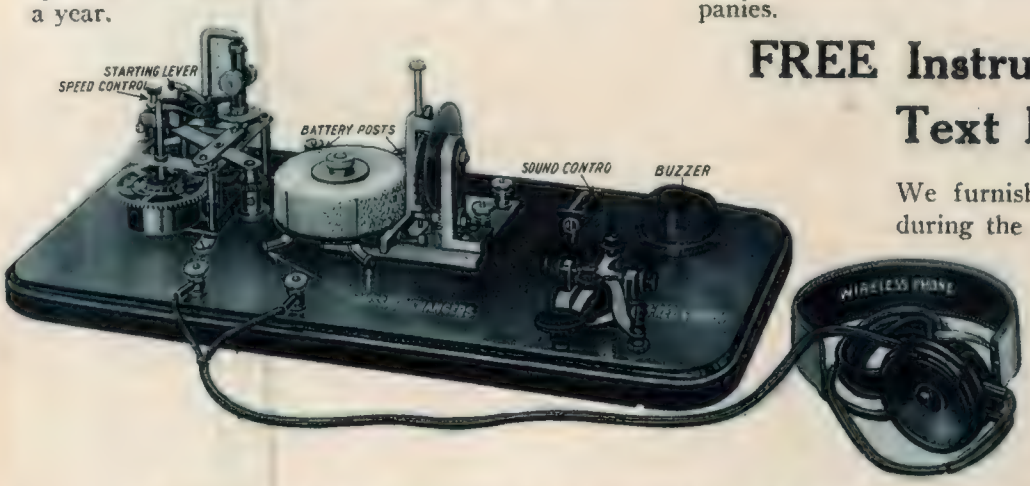

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(*Continued from page* 444)

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"You will forgive me for this recital of facts with which you are probably well acquainted, as I gave it merely as a means of leading up to my next point, which is: Are we justified in concluding that X-rays are the *ultimate* rays; that is, the rays of highest frequency which it is possible to produce? Is it not possible for the ether to be made to vibrate at rates substantially in excess of 1500 trillions per second, and if so, how? Well, since there is nothing to authorize an assumption that the ether cannot be made to vibrate at higher frequencies, it is logical to look for a means of effecting such an increase in rate of vibration. To this end, I searched and searched and at last, I, Pax Marriote, have discovered the secret—have found a means to make the ether vibrate at frequencies up to as high as a million trillion of vibrations per second, which I am convinced is the highest possible rate—have finally discovered the *ultimate ray,* the "Z" ray, the long sought ray that would decompose matter utterly into energy alone, the disintegrating ray!

Becoming excited toward the last, his voice had risen to a shrill screech, indescribably horrible to hear, and now, as he paused for breath, the terrific fury of the storm once more caught my attention. The thunder crackled and boomed till it seemed the very earth around us must be splitting, and at every volley the building seemed to give a lurch as from a physical blow. Actually, I felt that I must be going mad.

After he had taken a drink at the sink, he came over and stood before me once more, inspecting the ropes that bound my wrists, and tightening them again, thus destroying my one slim hope of escape. Then returning to his position by the table, he continued—

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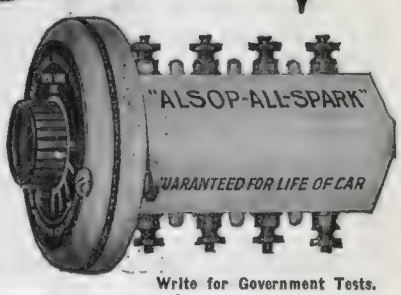

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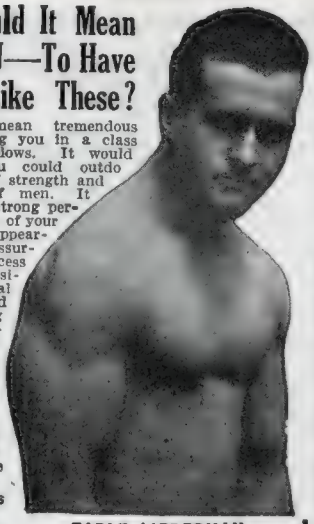

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were emitted from the opposite side of the alloy from that which the X-rays struck, or, in other words, the alloy seemed to act as a sort of transformer in which, by the action of light rays of one frequency on a surface of it, a molecular action was set up which produced either vibrations of a high frequency on the opposite surface.

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Going over to the switchboard, after this staggering recital, he closed two switches in rapid succession and with much sparking and crashing of circuit breakers, a low humming became audible from behind the switchboard and steadily increased in volume and shrillness till it filled the room with a high-pitched, musical hum.

Again the sense of unrealness assailed me, and I felt possest with an almost overwhelming desire to laugh—to cry out; but I fought it down, silently, desperately, knowing full well that I must maintain control of myself then or never. The room was becoming insufferably close, and my wet garments clung to me clammily. Suddenly the light went out, and so high strung were my nerves that I started up, lost my balance and fell heavily to the floor. After a moment's darkness, a dim shaded light was turned on, casting a glow over the table and on the strange man who called himself—Pax Marriote. He roughly jerked me back on to the bench and returned to his work.

In a sort of stupor I sat there and watched his never-ending adjustments.

"It may interest you," a voice was saying, and the words seemed to come from a great distance, "to know that I have installed a turbine-generator at a falls in the nearby stream. This furnishes me with ample power for conducting my experiments as well as for lighting the house. Now to continue, by means of this transformer and specially constructed Tesla coil I am able to cause a current to pass over the transformer plate ranging from 100,000 oscillations per second up to several millions. I use silver plated copper tubes in the high frequency circuit."

Quickly closing a switch, he seized the rheostat control and pointed excitedly to a square white screen in front of the machine. A square about six inches on a side and of a faint red color was visible. Slowly it changed to a deep red, then began to grow brighter, taking on a cherry tinge that soon changed to a dark orange.

"You see it! *You see it!*" he cried excitedly, at the same time moving the rheostat lever ahead.

The dark orange became brighter, then changed altogether to a yellow. With eyes glued to the screen, I watched the eerie phenomenon progress—breathlessly waiting while the yellow changed to green, to blue, to violet, and then faded out altogether.

"Now watch!" His voice had risen to a scream as he gave the lever a mighty shove.

I gave a little gasp as brilliant flames began to play about the contact points of the switches and long streamers floated eerily

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about the room, producing an electrical display more magnificent than I had imagined possible. A dull violet glow covered the table and all the apparatus, while the unmistakable odor of ozone became noticeable. Then glancing at the heavy screen I beheld the beginning of the miracle!

Slowly,—very slowly,—*the screen was dissolving*,—I use the word deliberately,—was dissolving into thin air. Not the slightest noise accompanied this strange sight and I could scarcely credit my senses, as before my eyes, I saw the absolute annihilation of this very appreciable quantity of matter; it appeared to be some kind of porcelain.

"Merciful heavens!" I screamed, in a sort of unreasoning panic, "turn it off—stop it—quit! STOP IT, I say!"

The ghostly streamers, the strange blue haze covering the table, the weird figure crouched over the control lever, the uncanny disappearance of the screen, the whir of the rotors, the intermittent crash of the thunder, all combined to produce a terrible effect upon me, and outraged reason was mercifully relieved as the room swam before my face and everything went black. A momentary sensation I had of delicious rest and quiet; then I knew no more.

* * *

I regained consciousness to find myself in absolute darkness with the rain beating upon my face. I tried to move and found that I was lashed to a chair. By straining my neck I could look to one side, and by the flashes of lightning made out a jagged hole in the wall thru which the rain poured in upon me. The storm, far from abating, had grown even more violent, and the thunder seemed to be crashing and crackling directly above the building. I caught the glint of metal before me, and, by the flickering glare of lightning flash, I saw with freezing horror that I was still in the workshop of Pax Marriote, that the chair to which I was strapped had been placed directly in front of his fiendish invention!

In unspeakable terror I heard footsteps outside the door, heard a key grate in the lock, heard the door open and close, heard the bolt shot home. There was a click and the details of the room sprang out in sudden brilliancy in the bright rays of the arc-light. I sat perfectly still, my eyes riveted to the demon machine by some horrible fascination. Recalling his remarks concerning "my disposal," and considering my present location directly in the path of the dread ray, left no doubt in my mind as to the fate in store for me. I was to be annihilated, utterly wiped out of existence!

With a curious feeling of detachment from my surroundings, I became aware that he had put on his goggles, apron and gauntlets and was standing over by the switchboard. Then came the low purring of the rotors as they commenced to gain speed and a terrific peal of thunder that shook the building like a leaf. A strong sulfur smell reached my nostrils, cleared my brain, and started me to coughing violently.

I looked up and saw him drest in his unmistakable, unforgettable manner. He was regarding me curiously thru the fantastic goggles.

"Humpf!" he began. "Wide awake at last, I——"

A peal of thunder drowned out the rest of his sentence.

"Now, look here, Pax Marriote, if that is your name, you seem to have some wild

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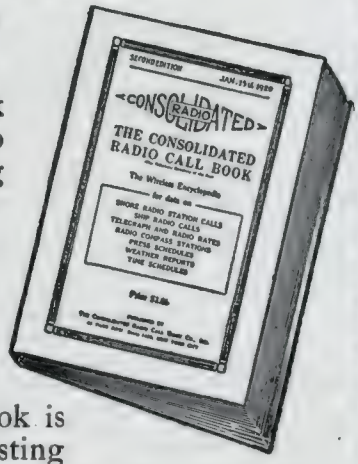

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idea that I came here to steal your invention, and yet I have told you the truth when I say that I did not even know that you were in existence when I entered this house. Surely you believe me."

"I most certainly do not," he replied coldly, "and even if I did I could afford to take no chances. Have you anything else to say?"

"Just this. That you will pay, and pay dearly for anything that you do to me. Understand that, please."

Striding forward he pulled something from his pocket, and before I was aware of his design, nor could I have done ought to prevent it, I was securely gagged.

"This unpleasant step becomes a necessity in the face of your continued insulting remarks," he informed me, adding dryly, "I regret the——"

Here a splitting crash of thunder blotted out his voice for a few moments.

When it died away, he was still talking, "and I presume that you understand what I intend to do with you. I can at least assure you that death will be painless, and I am sorry that you have been inconvenienced by the rain. The transformer got rather beyond my control and destroyed part of the wall before I could turn it off."

Such cold-blooded discussion caused the sweat to stand out all over my body. This past soon, however, and left me cool and calm.

Without more ado, he crost over to the control lever, switched out the arc-light, and began moving the lever arm at a good rate over the contact points.

So suddenly did this all happen that I scarcely realized what was going on until I glanced down at my shirt front. Imagine my unutterable horror when I saw the telltale patch of red light cast on my shirt directly over my heart!

For a moment my heart actually stood still, then the blood began racing madly in my veins, pounding in my temples till I thought they must surely burst. Tugging desperately at my bonds, I soon found that escape was hopeless, and meanwhile the red had changed to blue and this in turn to a violet ray. Even as I watched, petrified with fear, the violet faded out and soon after the awful streamers began to float about the room and the purple mist appeared upon the table.

The end could not be many moments away, and even then I fancied that I could feel a strange drawing sensation in my left side.

And, now that I sat there on the very brink of Eternity, I felt calm and collected.

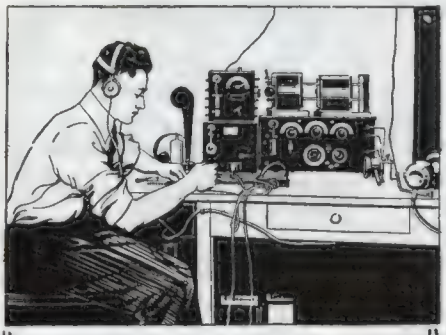
I found time to notice that the storm had suddenly ceased for a moment, that the forces of Nature seemed to be suspended for a short interval. Then came a crash as if earth and sky had met in collision, and the former had been shattered, and simultaneously, a vivid blinding sheet of flame enveloped the room. There was one awful throb of the tortured atmosphere and something struck me a terrific blow in the back that sent me halfway across the room, and I landed in a heap with twisted straps and pieces of splintered wood fastened to my wrists and ankles.

I think I realized, at the time, that the building had been struck, and I rose shakily to my knees in time to see Pax Marriote stagger backwards, his hand clapt over his forehead, and fall writhing to the floor.

Already the switchboard was vomiting flames and the whole of one wall was ablaze, so I made a great effort and slipt back the bolt on the door, succeeding in dragging myself out of the house and fifty feet away from it before I swooned.

* * *

I came to in Beaumont Hospital with Bryce bending over me. I felt very weak, and trying to move sent sharp pains shooting thru me.



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"Take it easy, Old Scout," Bryce was saying, "you need a rest."

"You—found—m-me?" I managed to blurt out.

"Right after the storm, Old Top. I soon discovered your trail where you cut into the woods and the rest was easy. By the way, were you inside of that shack?"

"Shack? Oh, yes, of course! I went inside to get out of the storm and it was struck by a bolt." I decided to omit the details of my experience. "Burned down, did it?"

"Clear to the ground. Must have been a close call for you. You were pretty badly burnt. And say,—funny thing,—there was a piece of strap fastened around your wrist."

"Is that a fact?" I drawled. "How odd."

I laid there in silence for some minutes, gazing at the ceiling. Then I felt impelled to ask.

"Were—were any—bodies found in the ruins?"

He looked at me perplexedly. "Why no. Why do you ask?"

"Oh, I just thought that perhaps,—just curiosity, you know!"

Just then a nurse came in, and, with a parting word, Bryce took his leave.

And so it happened that I spent my long looked for vacation in a hospital ward, and to this day I don't know whether Marriote perished with his terrible secret in the flames of that burning house, or whether he is still alive and may some day startle the world of science with an announcement of his achievement.

For my part, I hope that the secret of the *ultimate ray* is buried beyond all chance of recovery.

[THE END]

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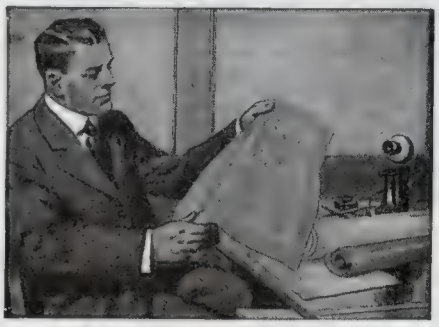

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☐ Telegraph Expert	☐ DESIGNER
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☐ MECHANICAL ENGINEER	☐ Private Secretary
☐ Mechanical Draftsman	☐ BOOKKEEPER
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☐ Machine Shop Practice	☐ Cert. Pub. Accountant
☐ Toolmaker	☐ Traffic Management
☐ Gas Engineer	☐ Commercial Law
☐ CIVIL ENGINEER	☐ GOOD ENGLISH
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☐ MINE FOREM'N OR ENG'R	☐ CIVIL SERVICE
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☐ Architectural Draftsman	☐ Textile Overseer or Supt.
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Home Electrics

By G. L. HOADLEY, M.E.

(*Continued from page* 386)

Poor adjustment of the distance the armature is separated from the magnets frequently causes the bell to fail to operate. The separation should be not less than 1-24 inch for the small bells up to ⅛ inch for the larger bells. Sticking of the armature to the magnets sometimes occurs, due to residual magnetism in the magnet cores. A thin piece of paper glued to that surface of the armature facing the poles of the electro-magnets will overcome this difficulty.

Poor adjustment of the sparking contacts is a common source of trouble. To adjust the contact spring the proper distance from the platinum tipt screw, hold the hammer against the bell. The armature should now *just not touch* the poles of the electro-magnet. Now, tighten the platinum tipt screw until it *clears* the contact spring by about the thickness of a sheet of brown paper. Let loose the hammer now and make certain the contact spring makes good contact with the tip of the screw. Next, try out the circuit so as to make sure the character of the ringing sound is satisfactory. Then tighten the setscrew to prevent the vibrating hammer altering the adjustment.

Sometimes the spring that bears the armature itself is either too strong (set back too far) or too weak. If too strong, the armature cannot be pulled over far enough to give a good blow; if too weak, the armature with attached contact spring will not return to its place against the platinum tipt screw. To ascertain which defect exists, operate the bell and press the spring lightly with a piece of wire first *toward* and then away from the electro-magnets. If the ringing is better in the first case, the spring is too strong, but if improvement is noted in the latter case, the spring is too weak.

Defective insulation of the winding of the electro-magnets occasionally happens on bells which have had hard usage. To ascertain this trouble and remedy it, place a smooth piece of iron ½ inch square across the poles of the magnet with the bell in circuit. Now, attach a one-pound weight to this ½-inch square iron by means of a string. If the magnets of a 2½-inch bell will not sustain this weight, they are too weak and the winding is probably short-circuited; that is, the current doesn't traverse the whole length of the coils. This makes the magnet very weak. Under these conditions, test to see if the winding is "shorted" thru the iron cores by connecting one pole of a dry cell to one of the magnet coil lead wires. Then draw the other battery pole across the clean iron faces of the electro-magnet coils. If any sparking results, it will be evidence of a "short" or "leakage" thru the iron cores, and the only remedy is to rewind the coils or else discard them.

Leakage may occur between the binding-screws and the base, or between the contact spring block and the base, and the contact pillar. Unless the connecting wires are covered with rubber tubing, leakage may occur between these wires and some part of the metal base. Carefully examine these places and apply a little glue or shellac to any suspected spot.

Summarizing, if a bell fails to ring, first, either loosen or tighten the adjusting screw of the contact pin, moving it closer to, or farther away from the armature spring as required. If the spring is too stiff, bend it toward the armature a little. A thin and sharp-pointed pin should be blunted as it offers too much resistance. Note whether the connections between the ends of the wires and the terminal screws are good and not dirty. Sticking of the armature cores can be prevented by inserting two brass pins in drilled holes in the core ends.

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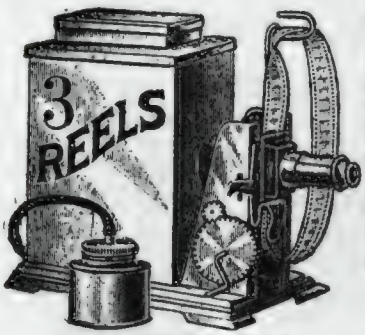

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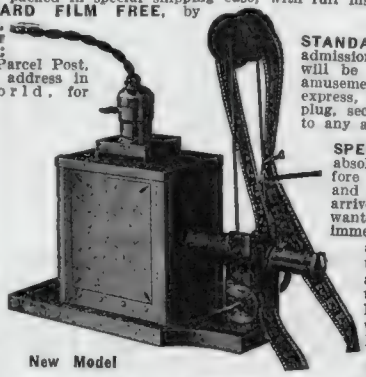

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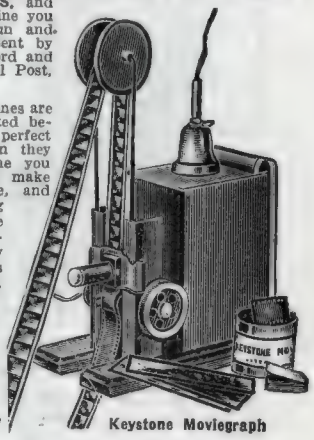

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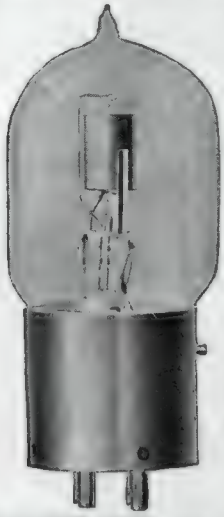

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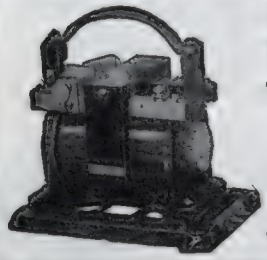

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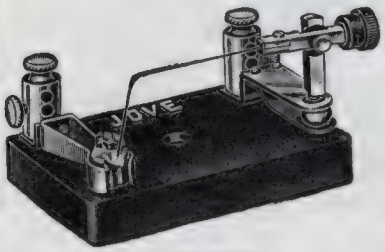

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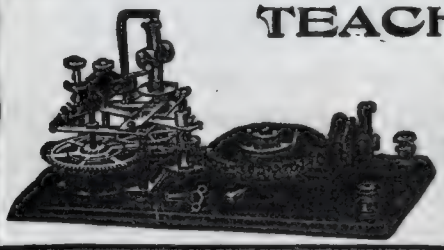

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Sperry Shoal Water Indicator

(*Continued from page* 363)

reaches a *minimum water depth.* This is inserted in the upper part of the second dial, the function of which dial is to give the propeller speed.

This is actuated by transmitters placed on the individual propeller shafts which are averaged by a device, similar to the one described in the Sperry Battle Tracer article, in the March issue of this publication. From the averaging device, impulses are transmitted to the dial giving an accurate indication of the speed. On one side of this second indicator is a set screw for adjusting the scale of minimum water depth, which can be accurately determined, inasmuch as a slight movement of the indicator either way is instantly noticeable.

A shallow water indication and the sounding of an alarm is given whenever the ship is operating in a draft of water considerably less than its overall length (as this is the point where the resistance of the water to the ship's speed is increased). For a given number of revolutions per minute for the propeller shafts, the actual speed is reduced by a considerable amount in shallow water, even as much as 50 per cent of normal. However, in actual practise, the two contacts for the alarm are held a certain distance apart so that the vessel can ride in the shallow water with a short margin of safety and is enabled to pass thru channels, etc., where water is not very deep.

Now, whenever the *ratio* of propeller speed to actual forward motion of the ship is upset, a warning is rendered, foretelling the dangerous location. Only one other condition can possibly change this ratio between ship speed and propeller speed, and that is the condition of the ship's bottom, but this can be compensated for.—*Photographs courtesy Sperry Gyroscope Company.*

Audion Poem Awards

(*Continued from page* 405)

3d Honorable Mention

THE WANDERING AUDION.

I was born in the brain of science,
I was clothed in a fragile glass,
I was bound to my work with copper wires
And wedged into place with brass.

While out of the world's aste saces,
Born on the radio wave,
Came the pulsing code-rit message
That taught me I was a slave.

That spoke of boats on the ocean,
And told of the work of men,
Describing the vibrant busy world,
So far away from my ken.

I conceived a desperate longing
To break my bonds and be free;
And wander over the wond'rous world,
Myself these things to see.

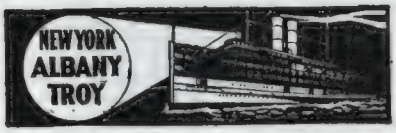
But my fragile shell made them wary;
They guarded me lest I break.
But they did not know, for I couldn't show
That my soul bore a lonely ache.

Yet, sometimes accidents happen!
Once while they were bringing me
Aboard a ship, for a trial trip,
I slipped off into the sea.

For many a moon I drifted,
And watched the ships sail by;
And saw, to my craving heart's content,
The wonderful summer sky.

(*Continued on page* 459)

HUDSON RIVER NIGHT LINES



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Original Audiotron Adaptors.....	$1.75
Standard "VT" Sockets with positive contacts.	$1.00
Moorhead Electron Relays with Standard VT base	$6.00

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"ELECTRIC SHOVELS" TO THE FRONT.

The development of "Electric Shovels" was discust by H. W. Rogers, an electrical engineer, in an interesting talk before the members of the General Electric Engineering Laboratory Club recently.

In outlining the development of the electric shovel of today, the speaker referred to the various changes in mechanical structure of electric shovels, dating back to the first steam shovels brought before the public, upon a manufacturing basis, some 50 years ago.

At present there are in the Ohio and Illinois coal fields electric shovels with the eight-yard bucket, equipt with two 340-h.p. hoist motors, and are practically a one-man shovel. Some of the different types of shovels are provided with friction clutches and have caterpillar tread construction.

As to the relative cost of operation, it was shown that the electric shovel operates at the rate of six to seven cents per ton of coal mined, making a saving of $9 for each working day shift, over the steam shovel.

During the course of Mr. Rogers' lecture, many slides were shown, illustrating the various shovels in use at the present time.

A Wartime Radio Detective

PART IV.

By PIERRE H. BOUCHERON.

(*Continued from page* 407)

have become known to persons located in various inns and hotels whose duty it was to notify the truck of our presence. This accounted for the fact that two weeks had now past without having discovered anything more tangible than certain sections of by-roads disfigured by large ruts made by the heavy wheels of the elusive auto.

Incidentally, our investigations up to this time had not proved entirely fruitless. Tips given us by the police and other agencies led to the discovery and dismantling of several illegal radio stations where the culprits were boys possest with perverse natures in that they thought it great fun to "listen-in" to what was going on in the ether by employing improvised indoor antennae and loops. In these cases nothing more drastic took place than severe reprimands with subsequent promises to behave in the future.

One case, however, proved more interesting than the others when a complete receiving installation was discovered in the home of a young man who had recently secured much newspaper notoriety. This "hero" was none other than the radio operator on board a certain large steamer attached to a West Indian run which had been but a short while back effectively sunk a short distance from the Jersey Coast. It was suspected at the time that the operator had been working into the hands of the enemy submarines by disclosing the presence of the ship thru an ill-timed radio signal. To make a short story still shorter the young man and his father were effectively taken care of by the Government.

All roads lead to an end and even a good cigar burns itself out so that finally our intense radio activities came to an abrupt and sudden end in the following manner:

For a week or so our "listening-in" operators had not heard the fluctuating signals and it began to look as if the truck had dropt thru a hole to the center of the island. Frequent and systematic trips thru main and by-roads as well as ceaseless search in barns and woods had so far failed to disclose the presence of the lorrie and its occupants. Even a close watch of the inn, where had first been secured the information, proved equally fruitless. The waiter had never returned to his post and upon cross-examination the proprietor explained that waiters

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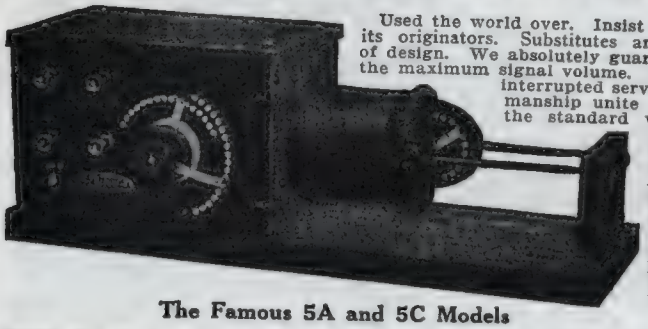

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and other employees came and went and that he could not be expected to keep track of their movements. Of course, he could not explain the existence of the motor truck—had never seen it, was not interested, etc.

One morning accompanied by an O N I investigator and with the use of a small car, we were traveling along one of the by-roads not far from the base of our operations when we presently noticed a small column of smoke pushing its way thru a wooded section to our left. More out of curiosity than anything else we decided to investigate and see who had started a fire in this locality and to what purpose. We traveled along for a short distance when we came to a makeshift road leading into the wooded part and of the kind used by farmers. We, therefore, turned our car in this new direction and had not gone very far when we suddenly came to a slight clearing where trees had been chopped down and carted away, leaving a great number of stumps scattered about.

SPY RADIO DISCOVERED AT LAST!

Lo and behold, there in the center of the cleared space was a large mass of twisted steel and charred wood from which arose a few lazy spurts of smoke. Judging from the remains of the framework this had evidently been a large motor truck. A great pile of lumber had been placed under the body to assist in the effective destroying of the car which seemingly had been burning for some time, as nothing but smoldering ashes remained.

It did not take a great amount of ratiocination to explain this strange and unusual sight. The truck was none other than the elusive machine we had been trying to locate for the past two weeks. With the aid of several buckets of water secured from a nearby stream we completely cooled the smoldering wreck. Sure enough, there was the twisted and bent motor generator unit of possibly a ½ k.w. output, inductances, quenched gap and what not. Altho the parts had evidently been subjected to a white heat which had melted the hard rubber, wood, and other composition pieces, the general outlines of the remaining metal portions left no doubt in our minds as to their having originally been radio instruments.

The solution of this final happening was simple. The operators of the truck had probably decided that the locality was too hot for them, and having realized that they could not hope to evade capture very much longer had decided to abandon their work, first taking the precaution to burn their equipment and *leave no trace* behind them. Fate had willed that we should just happen to pass the ruined car, possibly twelve hours after it had been set on fire, thus giving the two men ample time to escape to other parts. Also, considering the meager information we had as to their description it would have been out of the question to attempt to find them.

Suffice it to say that since the illegal traveling radio unit had been destroyed our work was finisht, and it is needless to add that thereafter, steps which cannot be disclosed here, were taken to prevent a recurrence of this nature.

CONCLUSION

Concerning the radio detective there is a great future for him even in peace times. He may be assigned to ferret out radio amateurs who do not confine their transmissions to lawful wavelengths and regulations. On the other hand, he may earn his salt by co-operating with the revenue agents who have lately discovered the reason for their inability to arrest moonshiners in certain sections of the country. Newspapers tell us that radio systems are in operation thru which the distilling plants are notified by cipher signals from the railroad station sent by confederates when danger threatens. When the law swoops down on a spot where the still has been reported they find the outfit missing.

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Audion Poem Awards

(*Continued from page* 456)

The warm sun's kiss in the daytime;
And at night the moon on the seas,
While, cradled in perfect comfort,
I was wafted on by the breeze.

I was borne to the spicy tropics,
And skirted the jungle shores,
And, from crowded docks, I saw strong men
Go off to their cruel wars.

Strange beasts on the edge of waters;
Bright birds on o'erhanging boughs,
Canoes and sampons and sailing sloops,
Steamers and yachts and scows.

I was caught by the Equator's current
And borne thru a coral reef,
Where many a stronger thing than I
Had drifted its way to grief.

But a providence seemed to guide me
(As always it had before);
A rolling wave with gentle care,
Laid me safe and sound on the shore.

They picked me up as a keepsake
(For men consider it strange
If the things they call inanimate
Should wander out of their range).

Well, if ever I'm back in the socket,
My work no longer will pall,
For when messages come from the wide, wide world,
I will understand them all.

Composed by J. Simeon Numen.

4th Honorable Mention

LINES TO AN AUDION.

O magic bulb that sailed the buoyant wave,
Frail crystal audion, vacuum tube that tells
Of feeble sounds that pulsing ether swells,
What perils didst thou—mystic wanderer brave?
Didst thou solve secrets of some coral cave
Where decked with pearls some lovely mermaid dwells?
Or didst thou hear some symphony that wells
Across the plenum of the celestial nave?
Didst some wave tell thee tales of long ago—
The mystery of deep space reveal to thee?
Didst thou hear thoughts no human brain can know;
Didst thou record what human eye can see?
Or on far reefs where tropic breezes blow
Hear footfalls on the sands of life's great sea?
I heard afar the belfries of the skies
Peal solemn anthems of a distant past,
I heard from out that wondrous vault so vast
What no dull mortal mind can now surmise.
What no mentality can now devise,
What groping science has not yet amassed.
I heard a story in the typhoon's blast,
'T would fill thy pigmy brain with mute surprise.
I wish I could your querulous thoughts console,
Your doubts and fears, anxieties drive away,
And tell of realms where stellar bodies roll
In nebulous orbits, 'mid the ether gray.
What I have heard I cannot now control,
Yet science may divulge a future day.

Composed by E. Jenkins.

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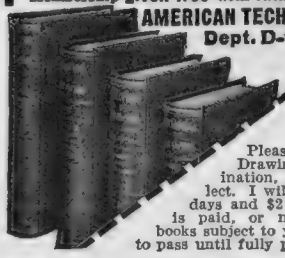

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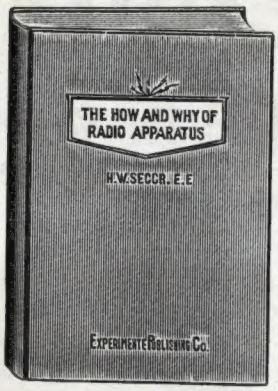

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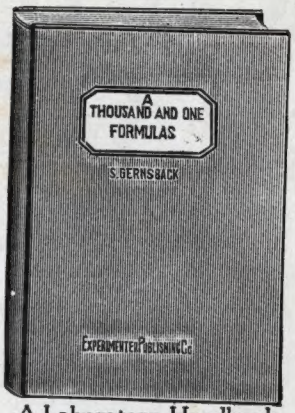

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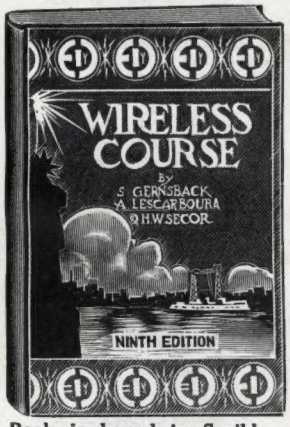

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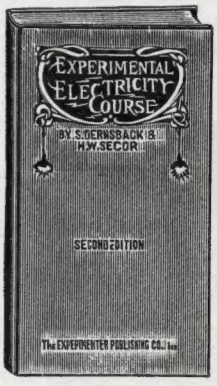

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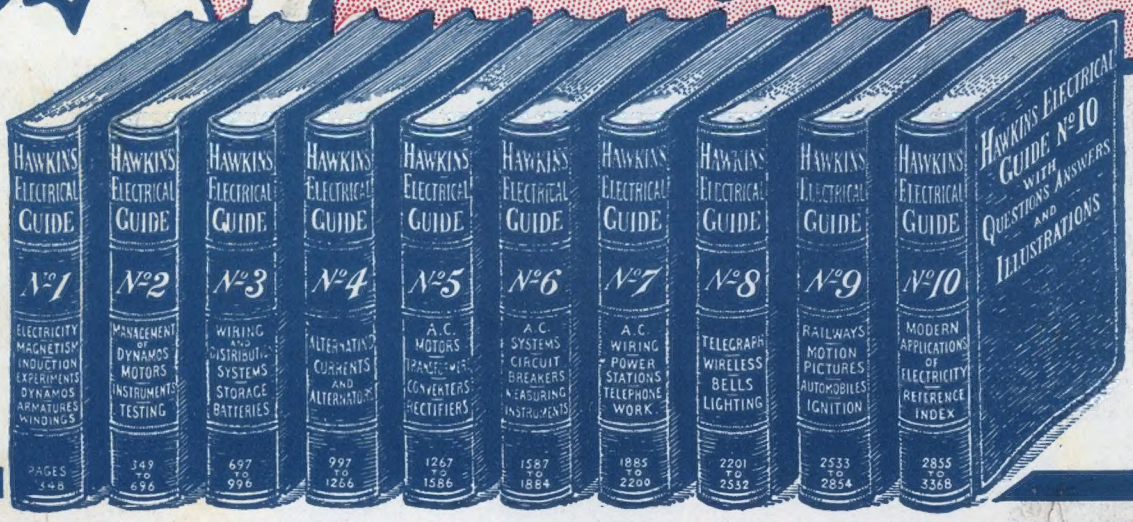
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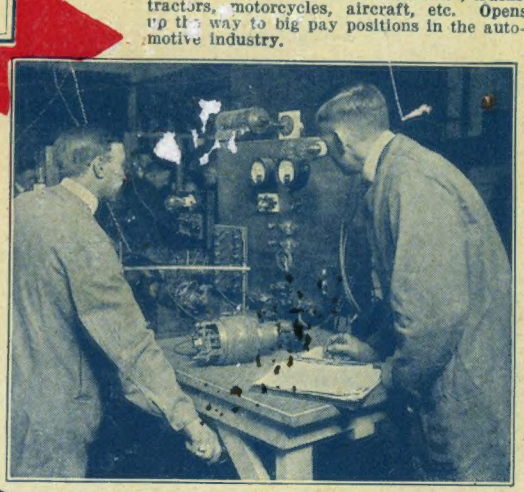

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